EXECUTIVE FUNCTIONS AND RISK PROPENSITY IN ADOLESCENT AND ADULT MALE DRIVERS: A COMPARISON

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Abstract

Young drivers between the ages of 16 and 24 are over-represented in motor-vehicle accident statistics worldwide. Several studies suggest that age could be a major crash risk factor in young drivers because their frontal lobes are not yet fully developed. The frontal lobes help inhibit impulsive behaviour and control executive functions which could otherwise result in higher risk taking propensity, impulsivity and reduced cognitive function which may lead to risky driving behaviours resulting in traffic accidents. This study examined the differences between 45 young (ages 16-18 years) and 32 adult (ages 25 years and over) male drivers in relation to cognitive ability, executive functioning, driving and risk attitudes, and impulsivity using cognitive tests and self-report questionnaires. The results showed that young drivers displayed attitudes significantly more approving of risk taking and risky driving, had significantly higher impulsivity, and were much more inclined to committing future driving violations. The adult drivers generally demonstrated higher cognitive ability and better executive functioning. A strong link was found between high risk propensity and riskier driving attitudes, which were both associated with better cognitive ability especially for young drivers. For the young drivers specifically, higher impulsivity and higher risk taking attitudes were linked with higher intentions to commit future driving violations. Also, for young drivers, poor fluency and switching was linked with a riskier driving attitude, and a safer attitude was linked to better inhibition. For the adult drivers, poor complex information processing was linked to higher risk taking attitudes**.** Further studies are needed to provide a better understanding of the young driver problem, particularly related to actual on road driving behaviour rather than self reported intentions.

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Literature Review

Young Drivers: Crash Statistics and Risk Factors

Young drivers worldwide consistently feature in official motor vehicle crash statistics while only making up a small proportion of the driving population (Begg & Langley 2001; Deery, 1999; Williamson, 2003). Young male drivers aged 15 - 24 years are at higher risk than either female drivers of the same age group or older male drivers (Williamson, 2003). The social cost and traumatic impact of traffic accidents on young drivers, their families and society is significant.

About 8500 young drivers die in car crashes each year in OECD countries and although they make up only 10.1% of the driver population, they are involved in 26.7% of driver fatalities (OECD, 2006). Studies in which crash rates were calculated in terms of age groups (e.g. 16 - 25 year olds) have shown the highest crash rates for the youngest licensed age groups (Williamson, 2003). According to a 2007 report by the World Health Organisation, road traffic accidents were the leading cause of death among young people between ages 10 - 24 years, with young males at higher risk for road traffic fatalities than females in every age group under 25 years.

Age appears to be the recurring factor impacting on crash risk. For example, in Maryland, USA, crash statistics from 1996 - 1998 showed that crash rate per million miles driven halved for each year of age between 16 and 18 (Ballesteros & Dischinger, 2002). Australian statistics from 1996 showed that serious crash involvement amongst those aged 17 - 20 years was about 12.5 times that of drivers aged 45 - 49 years (Wylie, 1996). Furthermore, crash involvement of drivers aged 21 - 25 years was substantially greater than that of all but the very elderly, and young drivers were projected to remain the largest group of driver

fatalities for at least 2 decades (Wylie, 1996). Additional Australian statistics from 2005 indicated that 16% of driving licenses were held by drivers aged 17 - 25 years, and that they were 3 times more likely to be involved in a serious crash than drivers aged 21 years and older (National Roads & Motorists Association, 2005).

In New Zealand, young drivers aged 15 – 24 years are over represented in all types of vehicle crashes and are considered to be up to seven times more likely to crash (per 100 million kilometres driven) than older drivers, other than the very elderly (Ministry of Transport, 2009). For example, New Zealand's Ministry of Transport (2009) has suggested that young drivers aged 15 -19 years are six to seven times more likely to crash (per 100 million kilometres driven) than drivers aged 45 -49 years, while drivers aged 20 -24 years are three times more likely to crash than drivers aged 45 - 49 years. More specifically, male drivers aged 15 -19 years are considered 11 times more likely to crash (per 100 million kilometres driven) than male drivers in the lowest risk age group of 55 - 59 years (Ministry of Transport, 2008). Also, female drivers aged 15 -19 years, who have a lower crash risk than males of the same age, are still nearly eight times more likely to crash (per 100 million kilometres driven) than female drivers in the lowest risk age group of 55 - 59 years (Ministry of Transport, 2008).

Looking at actual New Zealand crash statistics from 2008, young drivers aged 15-24 years were involved in 124 fatal traffic crashes, 787 serious injury crashes and 3,800 minor injury crashes (Ministry of Transport, 2009). Of these crashes, the young drivers were at fault in 106 of the fatal crashes, 632 of the serious injury crashes and 2,915 of the minor injury crashes, resulting in 122 deaths, 808 serious injuries and 4,262 minor injuries. The total social cost of crashes for 2008 in which 15 to 24 year old drivers were at fault was $1.1 billion; almost one-third

of the social cost ($3.83 billion) associated with all injury crashes (Ministry of Transport, 2009).

While driver age appears to impact on crash risk (as indicated by the aforementioned crash statistics), several specific factors are generally considered attributable to higher crash rates for young drivers. These factors are: inexperience, inattention, poor risk/hazard perception, impulsivity, thrill-seeking, sensation-seeking, and risky driving behaviors such as excessive speeding, dangerous overtaking, close following, drink driving, or driving after using drugs (Jonah, 1986; Williams, 1998). Similarly, Lee (2007) suggests the following reasons for the high young driver crash involvement: imperfectly learned vehicle control skills leading to poor control and less spare attentional capacity to accommodate unexpected demands; poor hazard perception; risk taking propensity; overestimating driving skills and underestimating the task demand of driving; sensitivity to peer influences in adopting inappropriate norms. All these factors are usually categorised into either 'the young driver problem' due to driving inexperience or 'the problem young driver' due to age related risk taking (Senserrick, 2006).

A common assumption, which is supported by some studies, is that young driver crash risk is entirely attributable to their insufficient driving experience. For example, Waller, Elliott & Shope (2001), using crash statistics from Maryland, USA, showed reductions in crash rate of around 17% per year of licensing across both age and gender with the greatest decrease of 22% in the first year of licensing. Mayhew, Simpson & Pak (2003) also found a significant 41% drop in crash rates per 10,000 novice drivers over the first 7 months of licensing; this effect was most pronounced for the youngest drivers, with 16 year olds showing a 56% drop and 17 year olds showing a 30% drop in crash rates. These studies

suggest the rapid decline in crash rates following licensing indicates crash risk for young drivers is more about their lack of experience than age related factors. Furthermore, McKnight & McKnight (2002) also found that for the first few years of driving the effects of inexperience appeared to greatly exceed those of age for drivers that were both novice and young.

While inexperience is considered a significant factor in crash risk, it does not provide a sufficient explanation for crash incidents of young drivers when inexperience is accounted for. Brown (1982) noted that even when external conditions are identical, some individuals are prone to creating more opportunities than others for accidents to happen. Jonah (1986) also suggested that even when the quantity and quality of exposure to risk are controlled for, young drivers (16-19 years old) still have the greatest risk of accident involvement. In support of this, Laapotti, Keskinen, Hatakka & Katila (2001) compared the self-reported crash and offence records of drivers of three different age groups (18-20, 21-30 and 31-50 years) while controlling for the level of driving experience. The results showed higher crash rates and offences for young novice drivers, particularly males. The study also showed that the types of driving incidents for young males were related more to risky driving rather than vehicle control skills.

A wide range of risk factors have been put forward to account for higher crash risk for young drivers. An increasing number of studies are supporting the notion that it is especially the interaction between inexperience and age, or 'the young novice driver' which is of primary concern in terms of actual crash risk. For instance, all beginners are by definition inexperienced, which on its own is a crash risk factor whatever the starting age (Williams, 2006). However, the crash risk is magnified when inexperience is coupled with characteristics of adolescence which includes risk taking tendencies, sensation seeking, excitement, emotionality, poor

judgment and decision making, and strong peer influences (Williams, 2006). It is this young & novice driver combination, which contributes to the complexity of the issue.

Young novice drivers are more likely to make driving errors when involved in complex traffic situations as they are the least likely to judge and respond appropriately because of their limited perception of the situation (Fuller, 1988; McGwin & Brown,1999). Young beginners are more likely than older drivers to perform risky driving behaviours such as speeding and close following (Jonah, 1986; Jonah 1997; Romanowicz, 1990). This driving style combines with their inexperience, manifested in lesser abilities to recognize and respond to hazards, which in turn produces their higher crash risk (Williams et al., 1995). The crashes of young novice drivers are more likely than those of older drivers to involve single vehicle events, speeding, and driver error, which reflect their risk taking tendencies coupled with inexperience (Williams et al., 1995).

Age: a Major Crash Risk Factor

While the combination of inexperience and age factors result in higher crash risk, it is difficult to sort out their relative contribution. For example, following too closely can reflect risk taking or merely inexperience with car placement; there are many crashes that involve both factors- driving too fast and running off the road, and failure to recover because of driving inexperience (Williams, 2006). Some studies that have tried to determine the contribution of age and experience to crashes have concluded that while both contribute, age becomes more of a factor the younger the licensing age (McCartt, Mayhew, Ferguson, et al., 2005). Furthermore, age related factors appear more likely to play a role in serious crashes (Williams, Ferguson & Shope, 2002).

Looking more closely at the effect of age on crash involvement, Arnett, Irwin & Halpern-Felsher (2002) noted that 16 and 17 year olds had higher crash rates compared to older teens. The crash rate for 16 year olds was two-and-a-half times higher than that for 18 year olds, and the crash rate for 17 year olds was 50% higher than for 18 year olds, even though 18 year olds had a higher crash rate than any older age group (Arnett et al., 2002). The suggested reason for the significant crash risk differences between drivers aged 16 and 18 years was that the 16 year olds were at a markedly different stage of adolescent development compared with 18 year olds (Arnett et al., 2002). Assum (1997) also found a link between age and crash risk through investigating the relation between attitudes and road accidents. Assum used self-report questionnaires in two phases to survey driver attitudes, accident involvement and driving mileage amongst 4420 Norwegian drivers aged 18 years and older. It was found that when no other factor was taken into account, accident risk was affected by driver attitudes. However, when age was taken into account, the relation between attitudes and accident risk disappeared. Assum (1997) concluded that age and annual mileage appeared to be more important to crash risk than attitudes.

As a result of the higher crash risk of younger drivers, many countries do not license until 17 or 18 years of age, which lessens the contribution of age related factors. Furthermore, most countries have introduced mandatory graduated licensing systems which provisions apply to all novice drivers, but mainly to young people because most beginner drivers are young. Thus, graduated licensing addresses the risks associated with youthful age: the "immaturity factor" (Williams et al., 2002).

From the growing number of studies on young drivers what is also becoming more apparent is that for young male drivers in particular, age appears to be the

main factor linked to higher crash risk. This is shown in Begg and Langley's study (2001) which examined changes in the prevalence of risky driving behavior among young adults at ages 21 and 26 years. They found that risky driving was predominantly a male activity but by 26 years of age, many had "matured out" of this behavior. MacDonald (1994) also found that age appeared to be the main factor for young males in relation to crash rates, while for older people and young females, experience had a greater effect. In addition to these findings, Yannis (2007) found that irrespective of age, males were more prone to driver traffic accidents than females- the greatest difference observed within the 18-20 years age group where male risk rates were 12 times greater than for females.

Together, studies suggest age is a major factor associated with young driver crashes, particularly for males. That is, adolescent drivers act and respond differently to adult drivers, leading to higher crash risk. Most beginner drivers are concurrently at a stage of adolescent development where risk taking is a normative feature, and brain development is at a stage at which controls on risk taking and cognitive processing capacity are not fully in place (Spear, 2000; Choudhury, Blakemore, & Charman, 2006). Williams (2006) suggests there is a continuum of age associated risk with driving and although there is a high risk adolescent subgroup of special interest, there are also many examples of 'model' teens being killed in crashes to warrant the need for all young drivers to be targets for intervention.

Recent advancements in neuro-imaging have enhanced the study of brain structure and function revealing that the brain, particularly the frontal lobes, is still developing and changing profoundly during adolescence and well into the third decade of life (Weinberger, Elvevag & Giedd, 2005). This has been suggested to

account for the very different age associated behaviours during adolescence and adulthood which are also reflected in, and affect driving behaviour and responses.

The Frontal Lobes and Executive Function

The frontal lobes are described as the 'orchestra leader' of the brain affecting all types of behavior by directing the activity of other sensory, motor, and cognitive systems and coordinating all major association sensory areas of the cortex and some areas of the limbic system (Martin, 2006, Weinberger et al., 2005). In general, the frontal lobe region mediates abstract thought, organisation of behaviour in logical sequence and temporal order, inhibition of responses, working memory, encoding and retrieving information, attention, intelligence, reasoning, emotional expression, empathy, motor movement and preparation, planning and executive functions (Martin, 2006; Weinberger et al., 2005).

The pre-frontal cortex or PFC (located beneath the forehead) is the specific part of the frontal lobe area mostly studied in adolescent brain development, and considered particularly relevant for driving behavior (Steinberg et al., 2004). The PFC could be considered as the 'CEO' of the brain (Luria, 1973) as it controls the 'executive functions' of the brain which relate to:

- Planning, prioritising and strategising
- Behavioural and emotional regulation and impulse control
- Attention allocation: dividing attention between tasks or stimuli, or sustaining attention (the ability to focus on a task and resist distraction over time)
- Problem solving and decision making
- Insight and reasoning
- Judging risk and risk propensity

- Working memory: the temporary storage and simultaneous manipulation of complex information
- Processing speed and complex information processing
- Sequencing tasks logically and temporally
- Cognitive flexibility: the ability to switch behavioral response according to the context of the situation or the ability of a person to see different aspects of an object, idea or situation and switch their "attentional set". (Steinberg et al., 2004; Weinberger et al., 2005).

Prior to recent neuroscience research findings, the brain was generally considered to be fully developed by the end of childhood or early adolescence. New research suggests that the PFC is one of the last areas of the brain to fully mature indicating that functions such as impulse control, planning and decision making are still maturing during adolescence (Weinberger et al., 2005). Furthermore, studies indicate that the frontal lobes and PFC are still developing well into our twenties (Choudhury et al., 2006; Lenroot & Giedd, 2006).

As the brain matures its wiring or circuitry (especially in the PFC) is coated with myelin or white matter for faster, more efficient and complex information sharing within and between brain areas which enables the performance of several tasks simultaneously (Giedd, 2004, Weinberger et al., 2005). The shift towards control into the frontal lobes is called frontalization (Sowell, Trauner, Gamst, & Jernigan, 2002). Dopamine inputs to the prefrontal cortex are still growing during adolescence, representing one of the neuronal mechanisms that increase the capacity for more mature judgment and impulse control (Weinberger et al., 2005). In other words, cognitive processes associated with inhibiting inappropriate behaviour, controlling impulses, planning and judging behaviour, and making

rational decisions are also still evolving during adolescence and hence not fully mature.

Consequences of Delayed Maturation

Executive functions and associated reasoning abilities, along with social and cognitive interactions continue to undergo vast shifts and unstable periods during adolescence. Consequences of this delayed maturation or developmental time lag are manifested in noticeable differences in adolescent and adult task performance, behaviour, and emotional response. This can be seen in brain imaging findings which reveal the adolescent brain does not fully engage the neural structures that are seen in adults completing the same task (e.g., working memory tasks), resulting in teenagers being more distractible (Casey et al., 1997). Also, although an adolescent's performance on tasks may be similar to that of an adult, findings suggest the adolescent brain requires much more processing capacity (e.g. working memory) for them to perform the same tasks successfully (Keating, 2007). Hinson, Jameson & Whitney (2003) demonstrated further that when working memory was taxed in adolescent participants, they made an increasing number of poor choices on a gambling risk task, and increasingly demonstrated a preference for short term rewards over greater long term rewards. With age, these executive functions become more focal and specialised while diffuse and irrelevant activity in this region is reduced (Casey et al., 1997; Gaillard et al., 2000).

In regards to behaviour and emotional response, adolescence is generally associated with higher risk propensity, sensation seeking, emotional intensity and impulsivity. It is a period of heightened risk in general where risk taking is hardwired into the adolescent brain (Reyna & Farley 2006). The emotional

intensity and higher risk propensity and the struggle to control them may lead to behaviours such as suicide, homicide, depression, substance abuse, violence, risk taking, sensation seeking and eating disorders (Dahl, 2004; Steinberg, 2008). Dahl (2004) considers the transformation during adolescence as a health paradox, describing adolescence as a developmental period of strength and resilience. However, despite these developmental improvements, mortality rates increase 200 percent over the same period of time (Dahl, 2004). A further health paradox described by Dahl (2004) is that adolescents have improved cognitive skills that support making logical and responsible choices and yet they behave erratically and recklessly, periodically disregarding risky behaviour and the consequences that follow.

Overall, the concept of delayed frontal lobe maturation has been described as being akin to starting the engine without a skilled driver behind the wheel (Dahl, 2001). For driving, it means young drivers may have insufficient cognitive processing capacity needed to react safely or anticipate hazards while trying to deal with the myriad demands of driving. It may also predispose them to be more impulsive with heightened risk taking tendencies, and engaging in risky driving behaviours that lead to traffic accidents.

Risk Propensity, Impulsivity and Driving

Cognitive processes associated with inhibiting inappropriate behaviour, controlling impulses, planning, judging behaviour, and making rational decisions are still evolving during adolescence (Weinberger et al., 2005). In the past several years, a new perspective on risk taking and decision making during adolescence has emerged, informed by advances in developmental neuroscience (Casey, Getz, & Galvan, 2008; Steinberg, 2008). According to this view, risky behaviour in

adolescence is produced from the interaction between changes in two distinct neurobiological systems: a socio-emotional system and a cognitive control system, both of which the prefrontal cortex is linked to (Steinberg et al., 2008; Steinberg 2010).

As Steinberg et al. (2008) explain in this model, adolescent risk taking is stimulated by a rapid and dramatic increase in dopaminergic activity within the socio-emotional system during puberty, leading to increased reward seeking. However, this increased reward seeking precedes the structural maturation of the cognitive control system and its connections to the socio-emotional system; a maturational process that gradually unfolds over the course of adolescence to permit more advanced self-regulation and impulse control (Steinberg et al., 2008). It is this temporal gap between the arousal of the socio-emotional system and the full maturation of the cognitive control system that occurs later, which creates a period of heightened vulnerability to risk taking during middle adolescence (Steinberg et al., 2008). It is suggested that impulsivity and sensation seeking contribute to this heightened risking taking, although it is unclear whether it is a combination of the two or either one or the other (Steinberg et al., 2008; Steinberg 2010).

Essentially, adolescence predisposes young people to engage in risky behaviours. Their risky behaviours can manifest in several ways, including risky driving behaviours such as speeding, following too closely, and rapid lane changes, which significantly correlate with a greater risk for crashes (Elander, West, & French, 1993; Preusser, Ferguson, & Williams, 1998). Similarly, less safety conscious attitudes associated with high risk taking during adolescence (e.g. finding speeding acceptable) predispose young drivers to higher involvement in accidents or towards committing driving violations (Assum, 1997). This is

illustrated in a study by Clarke, Ward & Truman (2005) of UK young drivers aged 17 to 25 years investigating motivational factors underlying driving behavior. It showed that young driver accidents were more frequently the result of 'risk taking' factors as opposed to 'skill deficit' factors (Clarke et al., 2005).

A more recent study by Hatfield & Fernandes (2009) further illustrates the impact of risk propensity during adolescence on driving behaviour. The study compared 277 young drivers (aged 16- 25 years) and 110 older drivers (aged over 35 years) using measures of risk propensity and risk motivations to examine the association of these measures with risky driving. All participants completed questionnaires measuring risk aversion, risk propensity (general and in accident, health, financial and social domains), and risk-related motives for risky driving. Compared to older drivers, younger drivers demonstrated: lower risk aversion, higher propensity for accident, health and social risks, and stronger motives for risky driving (Hatfield & Fernandes, 2009). Furthermore, these variables were also associated with risky behaviour in other domains (Hatfield & Fernandes, 2009). As indicated in the Hatfield & Fernandes (2009) study, there is also growing recognition that adolescents who engage in risky driving behaviours often participate in multiple types of risky behaviours, referred to as clustering or co-occurrence of risky behaviour (Vernick, Li, Ogaitis, et al., 1999).

As mentioned earlier, impulsivity (and sensation seeking) contributes to heightened risking taking (Steinberg et al., 2008). Impulsivity and other personality characteristics (such as extraversion, social deviance) have also been indicated as specific contributing factors to unsafe driving problems particularly for male drivers (Beirness, 1993; Hansen, 1988; Owsley, McGwin & McNeal, 2003). For instance, Owsley, McGwin & McNeal (2003) explored three personality dimensions (impulsiveness, venturesomeness, and empathy) in

relation to driving amongst 305 older drivers (ages 57–87 years old). Their results showed that subjects who reported driving errors and driving violations were more likely to have high impulsivity scores. Also, Dahlen, Martin, Ragan, & Kuhlman (2005) investigated the correlation between driving anger, sensation seeking, impulsiveness, and boredom proneness with aggressive and risky driving in a survey of 224 Mississippi college students. Dahlen et al. (2005) found that driving anger was most predictive of aggressive and risky driving, followed by sensation seeking, with modest contributions from impulsiveness and boredom.

Adolescence marks a period of high risk propensity and impulsivity leading to risky behaviours in driving and other activities. What is becoming more apparent is that these characteristics are shown to diminish or disappear with age, as many young people mature out of these high risk activities (Begg & Langley, 2001). For example, Steinberg (2010) found a linear effect of age on impulsivity, or in other words impulsivity declined with age. Also, as Jessor et al. found in their 1997 study, the decrease in risky driving among individuals was signaled by the change in behaviour and perceptions that occurred when reaching adulthood.

Cognitive Processing Capacity and Driving

The link between cognitive ability and executive function in relation to cognitive processing capacity needed for safe driving has mainly been shown in comparative studies of older drivers with and without neurological. From these studies the cognitive functions identified as important to driving are working memory, divided and sustained attention, cognitive flexibility (Kurzthaler et al., 2005), immediate recall, complex information processing , visuo-constructional and visuo perceptual abilities, set formation and shifting, and switching (Radford, Lincoln, & Murray-Leslie, 2004; Richardson & Marottoli 2003).

For instance, in older adults with and without mild dementia, Rizzo, McGehee, Dawson, & Anderson (2001) examined relationships between performances on standardized neuropsychological measures of cognitive abilities and driving performance. The neuropsychological tests included Rey Auditory, Verbal Learning Test - AVLT, Benton Visual Retention Test - BVRT, WAIS-III Block Design subtest, Judgment of Line Orientation, Complex Figure Test Copy and Recall - CFT, Controlled Oral Word Association, and Trail-making Test. The selected tests measured visuo-spatial and visuo-motor abilities, verbal and visual memory, attention, language, and executive functions. Their findings indicated weaknesses in visuo-motor abilities, executive functions, and memory were particularly associated with poorer driving and increased risk of crashing.

Richardson & Marottoli (2003) investigated cognitive variables associated with specific on-road driving behaviours in a sample of 35 older drivers (aged 72 years and older) who were non-clinic referred. The participants underwent a standardized on-road driving evaluation and were also administered tests of visual attention, executive function, visuo-spatial cognition, and memory. They found that participant driving scores were significantly correlated with visual attention, visual memory, and executive function. They concluded that visual attention (a cognitive function involving search, selection, and switching) in particular, played an important role in driving risk among older drivers (Richardson & Marottoli, 2003). Similarly, Donnelly et al. (1992) attempted to relate the performance on a road test of middle-aged and elderly subjects (21 healthy controls and 12 cognitively impaired patients) to their performance on tests of mental status, neuropsychological performance, driving knowledge, vision, and complex reaction time. Stroop scores (correct responses minus errors) of patients were

significantly lower than those of the healthy participants. However, correlations were low in regards to scores on the driving test.

Studies involving drivers with brain injury have also contributed to establishing the link between cognitive function related to safe driving. For example, Schanke & Sundet (2000) in their study of 55 patients with a brain injury or documented neurological disorder found that visuo-spatial difficulties, neglect, reduced psychomotor speed and executive dysfunction were impairments which may lead to unsafe driving. Lundqvist (2001) investigated the impact of impaired cognitive function on drivers with and without brain injury using four different study designs. The results showed group differences in terms of working memory, information processing speed, and divided and focused attention, which were important to safe driving.

Also, Galski, Bruno, and Ehle (1992) administered the Block Design test and Progressive Matrices (measuring visuo-spatial abilities) to 35 brain injured patients who also underwent an on-road driving evaluation. Galski et al. (1992) found that the Total score of the Block Design and errors on the on Progressive Matrices were correlated significantly and substantially (r = .60; r = -.61) with performance in the on-road driving evaluation. A further study by Galski et al. (1993) also found in a sample of 106 brain-injured patients that Block Design test and Progressive Matrices scores were significant in predicting driving evaluation failures.

Similarly, a study by McKenna, Jefferies, Dobson & Frude (2004) with 142 drivers with brain injury examined a battery of cognitive tests in terms of its sensitivity and specificity for predicting who would fail an on-road test following brain injury or pathology. The participants were administered the battery and underwent an on-road test after which the on-road test and battery results were

compared. McKenna et al. (2004) found that the overall accuracy rate of the battery in predicting a fail on-road was 92% and in predicting a pass on-road was 71%. They also found that non-verbal planning and the ability to monitor a verbal rule were particularly important factors for participants in relation to passing or failing the on-road test.

Other studies have examined the link between cognitive function and driving in terms of analysing driver crash history. For instance, some studies indicate that driving behaviour and accident involvement are correlated with intelligence and academic achievement which are associated with cognitive ability (MacDonald, 1994b; Murray, 1998; Sanchez Martin & Estevez, 2005). As an example, Murray (1998) found that male drivers with high involvement in accidents tended to have school marks lower than the average for men in the population.

Similarly, Sanchez Martin & Estevez (2005) studied 144 Spanish young drivers when they first enrolled in a driving course, at an average age 22.5 years, and again five years later. Cluster analyses produced two quite different cognitive profiles related to crash involvement: one with relatively high practical intelligence, good hand-eye coordination, and good perceptual-motor performance who were less involved in crashes; the other with lower practical intelligence, poor hand-eye coordination, and poor perceptual-motor performance were more involved in crashes. Sanchez Martin & Estevez (2005) concluded that those with lower intelligence and less education had more frequent accidents. Also, Vaez and Laflamme (2005) found that among all drivers less than 30 years of age who were involved in crashes, the odds of severe injury were higher for the youngest drivers, for drivers who were impaired by alcohol, and for drivers with less education. While these studies do not account for direct link between specific executive functions and safe driving, they do provide an indication of the

importance of cognitive ability, which is highly associated with executive function.

As mentioned, much of the research linking cognitive ability and executive function to driving performance has stemmed from studies of older adult populations. However, while there are apparent differences between these studies regarding group sample and size, and number and types of tests used which make comparing these studies difficult, they all suggest that cognitive ability and executive functions play a role in safe driving. There are also apparent parallels between older adult drivers with impaired executive function and unimpaired adolescent drivers. For example, as observed in adolescents, adults with impaired frontal lobes tend to be uninhibited, impulsive and often unable to suppress irrelevant information, are often easily distracted and falter at even the simplest tasks requiring sustained attention and short-term memory (Weinberger et al., 2005). In the very elderly executive functions tend to decline quite significantly, while at the other end of the spectrum (adolescence), they are one of the latest skills to develop (Choudhury et al., 2006; Weinberger et al., 2005). Relating these parallels to driving statistics, older drivers have a higher incidence of crashes per mile driven than all but the youngest drivers (Richardson & Marottoli 2003; Wylie, 1996).

Given the parallels between developing executive functions during adolescence and impaired executive function in adulthood, it is apparent that a critical level of executive function is required to drive safely. Similar to studies with older adults with and without neurological deficits, this critical level could be assessed for in young people by comparing executive function differences between adolescent drivers and adult drivers aged 25 and over. This is because at

25 years old, the factor of age disappears as a risk factor for crashes even after driving experience is taken into account (Mayhew et al., 2003).

Study Aims

The young driver problem is complex with a wide range of factors accounting for higher crash risk, many of which are linked to either driver age or driver inexperience. An increasing number of studies on neurological development during adolescence confirm a long-held view: teenagers are not the same as adults in a variety of key areas such as the ability to make sound judgments when confronted by complex situations, impulse control, risk propensity, and the ability to plan effectively. Such limitations reflect, in part, that the frontal lobes of the adolescent brain are not fully mature until the third decade of life (Weinberger et al., 2005). This delayed frontal lobe maturation linked with age could predispose young drivers to a higher risk of crash involvement. From this perspective, age is seen as a major factor in crash risk, particularly for young male drivers.

This study investigates the impact age has on male drivers in relation to driving attitudes, risk attitudes, and executive functions considered important to driving. It focused on comparing a group of 45 young (ages 16-18 years) and 32 adult (ages 25 years and older) male drivers, using questionnaires measuring driving attitudes, risk attitudes, impulsivity, and tests measuring cognitive ability and executive function. The specific aims of this study were:

1. To compare driving and risk taking attitudes, and impulsivity of young and adult male drivers.
2. To compare the cognitive ability and executive function of young and adult male drivers.
3. To determine if there were any associations between the measures of driving and risk taking attitudes, impulsivity, cognitive ability and executive function.

Method

Participants

A sample of 77 male, New Zealand drivers in was recruited for this study. They were required to be between ages 16-18 or 25 years and older and to have held a current full or restricted New Zealand driver license (class 1 or 1R respectively) for more than six months. They also needed to speak and read NCEA Level 1 English in order to complete the questionnaires and one to one tasks included as part of this study. The 16-18 year old participants (n= 45) were labeled the *young* group, and participants aged 25 and over (n= 32) were called the *adult* group. The young drivers consisted of 39 New Zealand Europeans, 2 New Zealand Maori, 1 Indian, 1 Sri Lankan, 1 New Zealander, and 1 with an unidentified ethnicity. Of the 32 adult drivers, 16 were New Zealand European, 10 New Zealand Maori, 2 Pacific Islanders, 1 Dutch, 1 African, 1 European, and 1 Indian.

The young participants used in this study were recruited as part of another study (The Frontal Lobe Project). Some were recruited from Hamilton Boys High School. Prior to doing so the school Principal and Board of Trustees were consulted about the project, after which they then granted permission for their students to participate in the study. The Life Skills course coordinator at the school allowed the students to participate in the project as part of the driver education component of the course. The remaining young participants were recruited through posters displayed in secondary schools throughout New Zealand. Applicants were selected on a ‘first come, first served basis’. This resulted in many young participants being recruited from throughout New Zealand, with representation across several ethnic and social backgrounds.

The adult participants specific to this study were recruited via various methods including word of mouth, through an advertisement (Appendix A) posted around the University of Waikato Social Sciences buildings and other public notice boards. Interested individuals contacted the researchers through email, phone or in person, after which meeting times and venues to complete the tasks were organized.

Materials

The self report questionnaires used in this study focused on the following areas: demographic information and driving history, participant driving behaviours and attitudes, risk-taking tendencies, and impulsivity. The self-report questionnaires are listed in the order they were administered: Demographics and Driving History, Driving Violations (DV), Driver Attitude Questionnaire (DAQ), Physical Risk Assessment Inventory (PRAI), Attitudes toward Risk Questionnaire (AR), and Barratt Impulsivity Scale (BIS).

For the one to one tests assessing cognitive function, the following materials were used and are listed in the order they were administered: Cancellation test, Trail Making test, Beck Anxiety Inventory (BAI), Beck Depression Inventory-Version II (BDI II), Digit Span subtest, Wechsler Abbreviated Scale of Intelligence (WASI), and selected subtests from the Delis-Kaplan Executive Function System (D-KEFS) which included Verbal Fluency, Colour-Word Interference, and Tower tests. A stop watch, pens and clip board were also used to assist with timed tasks and recording results and observations during testing. Dell Pentium computers with 15-inch monitors were used by 38 participants to complete the survey questionnaires online as part of another project. The

following section provides more detail about the questionnaires and one to one cognitive tasks used for this study.

Questionnaires.

Demographics and driving history. This questionnaire (Appendix E) asked participants their age, ethnicity, relationship status (e.g., single, in a relationship, married), the type of driver licence held (restricted or full), how long they have held their driver licence, and an estimate of kilometres they usually drive per week. Participants were then asked how many accidents and near hits during the past 12 months they were involved in and also how many traffic offences (such as speeding, following too close, etc) they were involved in either via convictions or warnings over the same period. An *accident* was described as any collision that occurred on public roads, wherein the participant was the driver, irrespective of who was at fault. *Near hits* were described as instances when the participant was the driver and narrowly avoided being in an accident on public roads, irrespective of who was at fault. A *conviction* was described in terms of when an offence has legal consequences resulting in a fine and/or demerit points. A *warning* was described as the participant being stopped by the police regarding their driving but no further action was taken.

Driving Violations questionnaire (DV). The DV (Appendix F) included 11 items, of which eight were derived from the Driver Behaviour Questionnaire (Parker, Reason, Manstead, & Stradling, 1995) and the last three items taken from the Speeding questionnaire (French, West, Elander, & Wilding, 1993). The statements have been slightly adapted, relevant to New Zealand road conditions. This questionnaire asked participants to indicate on a 5-point Likert scale, ranging from ‘0 (never or hardly ever)’ to ‘4 (nearly 100% of the time)’ how likely they were in the future to engage in each of the 11 undesirable driving behaviours.

Behaviours included impatient and aggressive actions and also exceeding the speed limit. For example, one item asks how often participants would expect to 'exceed the 100 km/h speed limit on the open road'.

High mean scores derived from this questionnaire represent a high intention to commit driving violations in the future. Both the Driving Behaviour questionnaire (Parker et al., 1995) and the Speeding questionnaire (French et al., 1993) of which the DV is derived from have been found to predict accident involvement. The wording explaining this scale's intent was changed slightly so it could be used more than once to evaluate the effects of interventions within other studies related to the wider driving behaviour project.

Driving Attitude Questionnaire (DAQ). The DAQ (Parker, Stradling, & Manstead, 1996) (Appendix G) is a 20 item questionnaire which gauges participant attitudes to rules and regulations on the road, and consists of four factors of risky driving behaviour related to speeding, drink driving, close following and overtaking. There were five items related to each of the four factors. Half of the statements presented as being in favour of the four factors, while the other half were presented as being negative towards them. Scoring was based on a 5 point Likert scale ranging from 1 (strongly disagree) to 5 (strongly disagree) with the midpoint labeled as *neither agree or disagree*. In terms of analysis, scales for some items had to be reversed so that higher scores consistently meant a less safe attitude. The total score range is from 20-100, with higher scores reflecting more disapproving attitudes towards violations, or in other words a relatively safer attitude towards driving.

Physical Risk Assessment Inventory (PRAI). Individuals perceive risk in different ways hence the PRAI (Appendix H) was included to assess individual perception of the physical risk of certain activities (Llewellyn & Clarke, 2003).

The PRAI consists of 27 items which participants are asked to indicate the level of physical risk they think are associated with various activities ranging from water skiing to smoking cigarettes. The level of risk was ranked on a seven point Likert scale, ranging from 0 (no physical risk) to 6 (extreme physical risk). Half of the items (1, 3, 5, 6, 8, 11, 12, 14, 17, 19, 21, and 24) were summed to provide a total Health Risk subscale score, and the remaining items (2, 4, 7, 9, 10, 13, 15, 16, 18, 20, and 23) were summed to provide a total Sports Risk subscale score. High scores indicate that participants associate many activities with a high level of physical risk.

Attitudes toward Risk questionnaire (AR). The AR (Appendix I) was used to determine of participants who show high levels of risk taking in driving also demonstrate this in other areas of life. The AR includes 10 items and utilises a 5 point Likert scale ranging from 1 (No like me) to 5 (Like me) to indicate how much each of the statements described the participant (Franken, Gibson, & Rowland, 1992). Half of the items (numbers 2, 3, 8, 9 and 10) were psychological risk items (e.g., "I do not let the fact that something is considered immoral stop me from doing it") of which the scores were summed, and the other 5 items (1, 4, 5, 6 and 7) were physical risk items which were summed to provide a total Physical Risks factor score. High scores on this questionnaire represent attitudes in agreement with risk taking.

Barrett Impulsivity Scale (BIS). The BIS (Appendix J) was used to measure impulsivity more specifically. This scale has a reported internal consistency between from 0.80 to 0.82 and is highly associated with risk taking (Patton, Stanford, & Barratt, 1995). It is a 28 item questionnaire asking participants to rank how well the descriptions of ways of acting or thinking related to them using 4 point Likert scale ranging from 1 (rarely/never) to 4 (almost always). Each item

related to either an ‘ideo-motor impulsiveness substrate’, a ‘careful planning (attention to details) substrate’, or a future oriented, ‘coping stability substrate’. However, only the composite score (ranging from 28-112) representing general impulsivity was obtained from this scale. Some items scores were reversed where appropriate with higher scores reflecting greater levels of self-reported impulsivity.

Cognitive Assessments.

Cancellation Test. Th*is test* was used to assess sustained attention (Diller, Ben Yishay et al., 1974). The task consisted of six rows of randomly generated letters which participants were required to scan each row and put a line through all the C’s and E’s as quickly as possible. Participant task completion times and the number of correct cancellations were the measures of interest.

Trail Making Test (TMT). The Trail Making Test (Part B) or in other words Trails Test was used to assess complex information processing comprising of attention, sequencing, mental flexibility and visual search behaviour (Lezak et al., 2004). Participants are required to connect consecutively and in alternating order, encircled numbers and then letters which are presented randomly over an A4 page. The time taken was the measure of interest.

The Beck Anxiety Inventory (BAI) & Beck Depression Inventory (BDI). Levels of anxiety and depression were assessed as they can interfere with cognitive performance. The *Beck Anxiety Inventory* (Beck & Steer, 1993) consists of 21 common symptoms of anxiety and requires participants to indicate how much they have been bothered by each symptom in the last week by ticking either the ‘not at all’ (or zero), ‘mildly’ ‘moderately’ or ‘severely’ (i.e. a score of 3). By summing the scores of each item a total anxiety score was obtained which was the measure of interest. The *Beck Depression Inventory* (Beck, Steer & Brown, 1996)

consists of 21 groups of statements, each group consisting of various 'symptom' levels with the associated scores increasing from zero for no symptoms to three for the most severe symptom. Participants were required to pick one statement in each group that best described the way they have been feeling over the past two weeks. Again the total score was the measure of interest.

Digit Span Test. Working memory was assessed using the well known Digit Forward and Backward Test (Lezak, Howieson, Loring, Hannay, & Fischer, 2004). The test was used because of its good external validity as demonstrated by its high correlations with other tests of executive function such as the Wisconsin Card Sorting Task, but also has demonstrated a lack of correlation with tests which assess other abilities (Homack, Lee & Riccio, 2005). Both the forward and backward scores and also the total Digit score were used.

Wechsler Abbreviated Scale of Intelligence (WASI). The WASI was used to assess general ability. The test is made up of the Vocabulary, Similarities, Block Design and Matrix Reasoning sub-tests of the Wechsler Adult Intelligence Scale. It provides standardised age appropriate scaled scores, which in turn provides a rapid and reliable measure of Verbal (VIQ), Performance (PIQ) and Full Scale (FSIQ, PsychCorp, 1999). In addition to using the collective IQ scores (e.g., Performance, Verbal, and Full IQ), raw scores of each participant from the sub-tests results will also be used to analyse group differences as the raw scores have not been age adjusted.

Delis Kaplan Executive Function System (DKEFS). Executive functions were assessed further using three sub-tests from the DKEFS which were Verbal Fluency, Colour Word Interference, and Tower of California. Each of these tests have split half reliabilities >0.6 (Delis, Kaplin & Kramer, 2001). The DKEFs is a relatively new set of tests designed specifically to assess executive function and

has a large and representative normative sample. It can be used to assess both children and adults. For the purposes of this study, only the raw scores of each participant from each of the sub-tests were used for analysis.

Verbal Fluency sub-test assessed the spontaneous production/ generation of words (Delis, Kaplin & Kramer, 2001). This required participants to generate as many words as possible beginning with the letters F, A and then S, followed by a category fluency assessment where the participants were required to produce animal and then boy's names beginning with any letter. The final part of this assessment required participants to alternate (switching) between the names of fruit and of furniture, referred as *cognitive switching*. A time limit of 60 seconds applied to each condition. Although age adjusted scaled scores were obtained for letter fluency, category fluency, category switching and switching accuracy, only the raw scores for these will be used for the group comparisons.

Inhibition and *cognitive switching/ flexibility* were assessed using the Colour Word Interference sub-test (Delis, Kaplin & Kramer, 2001). This test consists of four parts. Part one consisted of a page with five rows of randomly sequenced patches of blue, green or red colour. Participants were required to name the colours in order along each row as quickly as possible. The second part consisted of rows of randomly sequenced colour names printed in black type which the participant was required to read. Part three included items that were colour names printed in incongruent colours whereby the participant was required to name the colour of the ink and not the word. The final part also had colour names printed in incongruent colours but with half of these words within rectangles. Participants were required to name the colour of the ink for those words not in a rectangle, but read the word if it was enclosed in a rectangle. Inhibition and Inhibition/Switching raw scores were used for the group comparisons as they were not age adjusted.

Forward planning and *problem solving* was assessed using the Tower sub-test (Delis, Kaplin & Kramer, 2001). Nine items of increasing difficulty are included in this test wherein participants were required to construct 'towers' using 5 rings of various sizes, on a board with three pegs of equal height. For each item a certain number of rings were arranged on the pegs in a 'start position' and participants were shown a picture of the 'end position'. They were instructed to create the arrangement in the picture by moving one block at a time between the pegs using only one hand, and without placing a larger block on a smaller block. Participants were also instructed to complete the arrangement as quickly as possible using as few moves as possible. For the purposes of this study, only the Tower overall achievement score was used in the group comparisons.

Procedure

Ethical approval for this study was obtained from the School of Psychology, University of Waikato Ethics Committee. Written consent was obtained from participants after briefing them about the details of the study and informing them that they would be given complete confidentiality, anonymity, and the right to withdraw at any time without penalty. Participants were given the opportunity to ask questions about the study at any time and also the option of receiving a summary of the study's findings via email once the research was complete. For their participation, participants were given the option of either receiving two $10 MTA vouchers or a course credit if they were first year Psychology students at the University of Waikato.

Following recruitment, meetings were scheduled and held with participants who were each provided with an information pack and briefed about the project. A consent form was included in the information pack which each person was

asked to read and sign prior to their participation, and reminded of their right to withdraw from the study at any time. Participants were also informed that once they completed the questionnaires and one to one tasks, they would receive either two MTA vouchers or course credit.

After obtaining consent, each participant was then assigned a unique subject number to identify them and then presented with the survey questionnaires to complete. The survey questionnaires were completed either online or using paper form. For those who completed the questionnaires in paper form they were given an option to complete these in their own time, either before or after the one to one cognitive assessments. All questionnaires and one to one assessments were administered to participants individually.

Venues used to conduct the one to one tasks included either a medium size computer lab at the University of Waikato, a quiet room at participant's homes, schools or workplaces. All the one to one tasks in this study were presented to participants in paper form. Instructions were given to participants (Appendix K) about the one to one tasks summarized in the following statement:

"I'll be asking you to do a number of things today like defining words and solving different kinds of problems, and I will be asking you how you've been feeling during the past two weeks. Remember most people can't complete or finish all the tasks, but please give your best effort on all the items. Do you have any questions about what we are going to do today?"

A further explanation was given that some of the tasks would be timed and that they would be informed of this prior to commencing that particular task. Each participant was then presented with further specific instructions in relation to each of the one to one tasks. On average, participants took approximately two-and-a-half hours to complete both the questionnaires and the cognitive assessments.

Data Analysis and Statistical Consideration

Some items in the Demographics questionnaire were selected for further analysis while others were discarded. It was decided that the terms 'convictions' and 'warnings' in the demographics questionnaire should be viewed as equivalent in terms of driving violation, as they are only distinguishable by police action at the time (i.e., giving a ticket or just a warning). Therefore, they were combined into a single variable called *violations*. Each questionnaire and cognitive assessment was scored in accordance with the corresponding administration instructions. All data were then initially recorded onto a Microsoft Office Excel 2007 spreadsheet and then transferred into SPSS for Windows (Version 16.0) to conduct analyses. Independent Samples t-tests were used to compare mean scores of the two groups obtained from their responses to the questionnaires and their performance on the cognitive assessments. Pearson's correlations (2-tailed) were conducted to determine whether there were any significant associations between the different measures used in this study.

Results

Background and Driving History

The demographic questionnaire results provided information about the driving history and background of participants. At the time young drivers were tested, the mean length of time holding a restricted licence was 8 months (range 2-20 months). In comparison, the adult driver group had held a restricted or full licence an average of 16 years, (range 2-40yrs).

Table 1 displays the driving history of the two groups over a 12 month period regarding weekly distances travelled, involvement in accidents, near misses and violations. During the 12 month period, the young group had driven on average half the distance driven by the adult group (the majority of the young driver group travelled within a range of 50 to 100kms per week). The driving distance range for the adult group was more widely spread than the young group. Although the young group on average had driven less than the adult group, they reported a higher percentage of involvement in an accident, near miss, and traffic violation than the adult group. As Table 1 shows, the number of young drivers involved in an accident, a near miss, and/or a violation was almost double the number of the adult group in the same 12 month period.

Table 1

12 Month Driving History for the Young and Adult Male Driver Groups

	Young Group	Adult Group
n	46	32
Mean (Range) weekly kilometres driven	89 (0- 500)	189 (20- 1000)
Number (%) involved in an accident	8 (17.40)	4 (12.50)
Number (%) involved in a 'near miss'	36 (78.30)	20 (62.50)
Number (%) involved in a violation	42 (91.30)	20 (62.50)

Closer examination of the data revealed that there were 5 outliers compared to all other participants in terms of reported accidents, near misses and/or violations. In the young group, 1 young driver reported involvement in 6 accidents as well as 5 near misses and 5 violations. Another young driver reported being involved in 11 near misses and 8 violations, while further young driver reported 11 violations and 3 near misses. Of the adult group, 1 adult driver had reported 12 near misses with another adult driver reporting 6 violations.

Comparing Driving and Risk Taking Attitudes, and Impulsivity

Independent t-tests were conducted to compare the responses of the young and adult groups to the following questionnaires: Attitudes toward Risk (AR), Physical Risk Assessment Inventory (PRAI), Barrett Impulsivity Scale (BIS), Driving Violations (DV), and the Driver Attitude Questionnaire (DAQ). Cronbach's alpha scores were calculated for each questionnaire which showed good internal reliability for the majority of the questionnaires, and a somewhat lower internal reliability for the DAQ Total ($\alpha = 0.60$). These are all displayed in Tables 2 and 3.

Risk attitudes and impulsivity. Table 2 displays the results of the young and adult driver groups relating to mean scores, standard deviations and t-test values for the AR, PRAI, and BIS questionnaires. The young group mean scores for the AR total, the two AR subscales (Physical; Psychological) and for the BIS were all higher than those of the adult group. For the PRAI, the adult group had higher mean scores for the PRAI total and its two subscales (Sport; Health) compared to the young group. The t-test results showed statistically significant differences between the two groups for the AR total, the two AR subscales and the BIS as indicated in Table 2.

Table 2

AR, PRAI and BIS Results for the Young and Adult Male Driver Groups

Questionnaires	Young Group	Adult Group	t	α
AR (*n*)	43	32		
Total Mean (SD) Score	30.50 (7.84)	22.00 (5.92)	5.20**	0.89
Physical Mean (SD) Score	16.93 (4.56)	13.60 (3.19)	3.60**	0.85
Psychological Mean (SD) Score	13.65 (4.26)	8.40 (4.08)	5.40**	0.85
PRAI (*n*)	45	32		
Total Mean (SD) Score	89.78 (19.58)	96.69 (19.67)	1.50	0.66
Sport Mean (SD) Score	39.30 (12.74)	44.22 (10.29)	1.80	0.91
Health Mean (SD) Score	50.50 (10.01)	52.50 (12.02)	0.78	0.87
BIS (*n*)	37	30		
Total Mean (SD) Score	65.00 (10.25)	60.20 (8.10)	2.10*	0.75

Note. df= 73 for AR; 75 for PRAI; 65 for BIS. *p<0.05; **p<0.01

Driving attitudes. Table 3 summarises the DV and DAQ data for the two groups. The DV data shows that the young group mean score (13.65) was almost double the mean score obtained by the adult group (8.60). The DAQ data shows overall that the mean scores for the young group for the total score and the four subscales were higher than those obtained by the adult group.The t-test results showed statistically significant differences between the two groups for the DV total mean score and only for the Overtake subscale of the DAQ. Of note, although not shown in Table 3 regarding the DV questionnaire, is that the young group indicated they anticipated driving even though over the blood-alcohol limit about 75% of the time, compared to 25% of the time indicated by the adult group.

Table 3

DV and DAQ Questionnaire Results for the Young and Adult Male Driver Groups

Questionnaires	Young Group	Adult Group	t	α
DV				
Total Mean (SD) Score	13.65 (7.86)	8.60 (5.34)	3.30**	0.87
DAQ				
Total Mean (SD) Score	57.40 (8.71)	53.90 (9.21)	1.70	0.60
Speed Mean (SD) Score	15.80 (3.54)	15.47 (2.92)	0.40	0.68
Drink Mean (SD) Score	13.17 (3.64)	12.25 (3.96)	1.10	0.64
Close Mean (SD) Score	13.59 (3.52)	12.78 (2.61)	1.10	0.71
Overtake Mean (SD) Score	14.85 (2.76)	13.41 (3.42)	2.05*	0.66

Note. n= 46 for the Young Group and 32 for the Adult Group. df= 72.5 for DV and 76.0 for DAQ. **p< 0.01; *p< 0.05.

Summary of findings. The findings indicate that the young drivers displayed attitudes that were more accepting of or agreeable to risk taking and risky driving, and were also more inclined to committing future driving violations than the adult drivers. Furthermore, the young drivers as a group were also significantly more impulsive compared to the adult group.

Comparing Cognitive Ability and Executive Function

As anxiety and depression are known to impact cognitive test scores, all participants were screened using the Beck Anxiety Inventory and Beck Depression Inventory. Results indicated that all participants scored in the mild range for each scale; hence these scores were not used in any subsequent analysis.

The results from the all the neuropsychological assessments measuring cognitive ability and executive function are displayed in Tables 4 and 5. Independent samples t-tests were used to compare the scores obtained on these measures. Aside from the VIQ, PIQ and FSIQ scores which are age adjusted, raw scores from the other test results were used for comparison as scaled or age adjusted scores would mask any significant differences between the two groups.

Cognitive ability. The Wechsler Abbreviated Scale of Intelligence (WASI) was used to measure general cognitive ability from which cumulative scores relating to *Verbal Intelligence Quotient* (VIQ), *Performance Intelligence Quotient* (PIQ) and the *Full Scale Intelligence Quotient* (FSIQ) were produced. Table 4 shows the results for cognitive ability. Overall the adult driver group performed better than the young driver group in the FSIQ, VIQ and PIQ. There were statistically significant differences between the two groups in FSIQ and PIQ scores. As the VIQ, PIQ and FSIQ scores were all age adjusted, the raw scores for the separate subtests relating to Vocabulary, Block Design, Similarities and

Matrix Reasoning were used to compare the groups further. The adult driver group mean scores were higher than the young driver group in Vocabulary, Block Design, and Similarities although the young driver group had a slightly higher mean score for Matrix Reasoning. There were statistically significant differences between the two groups for the Vocabulary and the Similarities subtests.

Table 4

General Cognitive Ability Results for the Young and Adult Male Driver Groups

Cognitive Ability	Mean Scores	Young Mean Score (n=40)	Adult Mean Score (n=28)	t
General Ability				
	VIQ	102.80± 1.9	105.60± 2.9	0.90
	PIQ	106.40± 1.7	114.70± 1.8	3.30**
	FSIQ	105.00± 1.7	110.90± 2.1	2.20*
	Vocabulary (Raw)	54.45± 1.29	59.96± 1.98	2.44*
	Block Design (Raw)	52.58± 1.80	53.36± 2.26	0.27
	Similarities Raw	34.70± 0.65	37.54± 0.99	2.50*
	Matrix Raw Score	28.42± 0.50	27.86± 0.71	0.68

Note. *p<0.05; **p<0.01

Executive function. Table 5 displays the data obtained from the executive function measures for both groups. The Cancellation Time test (sustained attention) and the Trails Part B test (complex information processing) mean times for each group were recorded. The mean number of errors in the Cancellation Time test was also recorded for each group. The adult group mean times (in seconds) for both the Cancellation Time and Trails Part B tests were faster than the young group, and the adult group also had fewer errors in the Cancellation Time test. The Digits Forwards and Backward test (working memory) results

showed that the Digits Total and Digits Forward mean scores for the adult group were somewhat higher than the young group. However, the Digits Backward mean score were the same for both groups. T-test results for each of these measures showed that there was only one statistically significant difference between the groups, which related to the adult group's faster meant time in completing the Cancellation Time test.

The DKEFS was used to measure the remaining areas of executive function also displayed in Table 5. The data for letter and category fluency (fluency) shows that the adult group mean scores were higher than the young group. Also, the adult group mean scores for category switching and category switching accuracy (switching) were higher than those of the young group. Colour/Word subtest (inhibition and cognitive flexibility) results show that the young group mean score was somewhat higher than that of the adult group for the inhibition task while the adult group mean score was slightly higher than the young group for the inhibition/switching task. For the Tower Test (planning and problem solving) the adult group obtained a higher mean achievement score than the young group. T-test results showed statistically significant differences between the two groups for letter fluency, category switching and category switching accuracy, all of which the adult group had higher mean scores. In other words, for those particular tests the adult group performed significantly better than the young group.

Table 5

Executive Function Measure Results for the Young and Adult Male Driver Groups

Executive Functions:	Measure	Young Mean (n=40)	Adult Mean (n=28)	t
Sustained Attention				
	Cancellation Time	105.20± 3.7	90.30± 4.1	2.60*
	Cancellation Errors	4.40± 0.7	3.40± 0.9	0.86
Complex Information Processing				
	Trails Part B Total Time	84.90± 5.90	71.50± 4.30	1.67
Working Memory				
	Digits Forward	10.20± 0.40	10.90± 0.30	1.28
	Digits Backward	7.30± 0.50	7.30± 0.50	0.06
	Digits Total	17.50± 0.80	18.20± 0.70	0.59
Fluency & Switching				
	Letter Fluency	34.20± 1.70	42.60± 1.80	3.34**
	Category Fluency	38.90± 1.40	40.00± 1.40	0.49
	Category Switching (b)	12.30± 0.40	13.80± 0.60	2.13*
	Category Switching Accuracy (c)	10.50± 0.40	12.10± 0.60	2.08*
Inhibition & Cognitive Flexibility				
	Inhibition	53.70± 1.60	51.80± 2.50	0.70
	Inhibition / Switching	59.90± 1.80	60.40± 2.90	0.16
Planning & Problem Solving				
	Tower Overall Achievement	17.80± 0.50	18.80± 0.60	1.16

Note. a = df = 66; b. df = 48.48; c. df = 47.63; * = $p < 0.05$, ** = $p < 0.01$

Summary of findings. In general the findings indicate that the adult group performed better than the young driver group in general ability and executive function measures. For general ability, the adult group performed significantly better than the young group in the PIQ and FSIQ. In relation to the general ability subtests, the adult group achieved significantly higher mean raw scores than the young group in the Vocabulary and Similarities subtests. Regarding executive functions, the adult group performed significantly better than the young group in areas of sustained attention, fluency and switching.

Determining Associations between the Attitudes, Impulsivity, and Cognitive Measures

The final aim of this study was to determine whether there were any significant associations between the different measures used in this study. Pearson's correlations (2-tailed) were conducted separately for the young driver and adult driver groups as there were statistically significant differences between the groups on some of the measures. The first correlations were carried out between the driving attitudes questionnaires (DV and DAQ) and the cognitive tests. Further correlations were carried out between the DV and DAQ questionnaires, the risk attitudes questionnaires (AR and PRAI), and Barratt Impulsivity Scale (BIS). The final correlations were conducted between the AR, PRAI, BIS, and the cognitive tests.

Driving attitudes, cognitive ability and executive function. Table 6a (young group) and Table 6b (adult group) display correlations between the DV and DAQ, and cognitive tests. For the young driver group there were no significant correlations between the DV questionnaire and any of the cognitive ability or executive function measures. However, there were several statistically significant

correlations between general cognitive ability and executive function measures and the DAQ. There were significant positive correlations between the DAQ Total and PIQ, Block Design, Matrix and Digits Total. The DAQ Speed subscale followed a similar trend, with positive correlations with PIQ, Block, Matrix, Digits Total, and also with Inhibition / Switching. Significant positive correlations were also shown between the DAQ Drink subscale and PIQ and the Digits Total. A further significant positive correlation was between DAQ Overtake subscale and the Matrix and Digits subtests. A significant negative correlation was shown between the DAQ Close Following subscale and Category Fluency, Switching and Switching Accuracy subtests.

These correlations indicate that for the young drivers, higher general ability in the form of performance IQ was significantly related to riskier driving attitudes, particularly regarding speeding, drink driving and overtaking. Riskier driving attitudes of speed, drink driving and overtaking also related significantly to better working memory. A riskier attitude to speeding was also significantly related to better cognitive flexibility. Furthermore, the negative correlations appear to indicate that poor fluency and switching executive functions were related to a more approving attitude to close following.

Table 6a

Young Male Driver Group Correlations between Driving Questionnaires and Cognitive Ability & Executive Function Measures

	DV Total	DAQ Total	DAQ Speed	DAQ Drink	DAQ Close	DAQ Overtake
VIQ	-.267	-.071	.040	-.046	-.055	-.146
PIQ	.148	.416**	.394*	.319*	.108	.286
FSIQ	-.104	.165	.239	.129	.015	.045
Vocabulary	-.269	-.108	-.048	-.159	-.018	-.052
Block Design	.211	.381*	.373*	.277	.133	.222
Similarities	-.264	-.069	.045	.068	-.091	-.251
Matrix	.051	.406**	.378*	.309	.075	.328*
Cancellation Times	-.145	-.199	-.281	-.005	-.065	-.205
Trails Times	.050	-.033	-.132	.059	.096	-.151
Digits Total	.193	.331*	.317*	.321*	-.063	.324*
Letter Fluency	.094	.080	.097	.194	-.223	.165
Category Fluency	.063	-.184	-.147	.020	-.325*	-.021
Switching	-.077	-.230	-.078	-.065	-.392*	-.050
Switching Accuracy	-.063	-.151	-.029	.015	-.365*	.000
Inhibition	.045	-.046	-.006	-.103	.224	-.288
Inhibition Switching	.233	.204	.344*	.083	.094	.005
Tower Achievement Score	-.132	-.017	-.060	-.234	.070	.243

Note. *p<0.05; **p<0.01.

Table 6b displays the adult group correlations between the DV, DAQ and the cognitive tests. The table shows that there was a significant negative correlation between DAQ Drink subscale and the Trails test. This indicates that for the adult group, a more approving attitude to drink driving was related to better complex information processing. There were no other significant correlations.

Table 6b

Adult Male Driver Group Correlations between Driving Questionnaires and Cognitive Ability & Executive Function Measures

	DV Total	DAQ Total	DAQ Speed	DAQ Drink	DAQ Close	DAQ Overtake
VIQ	.052	.207	-.013	.220	.144	.217
PIQ	-.116	-.097	-.283	.203	-.085	-.189
FSIQ	.010	.157	-.107	.273	.110	.127
Vocabulary	.058	.283	.035	.249	.261	.265
Block Design	-.278	-.157	-.249	.138	-.136	-.271
Similarities	-.025	.195	.080	.199	.062	.189
Matrix	.014	-.097	-.292	.120	-.093	-.084
Cancellation Times	-.188	-.234	-.016	-.360	-.214	-.057
Trails Times	-.051	-.363	-.152	-.394*	-.217	-.249
Digits Total	.224	.296	.159	.144	.293	.289
Letter Fluency	.190	.127	.015	.238	.053	.025
Category Fluency	.326	.115	.037	.149	-.063	.154
Switching	.359	.079	.007	-.069	.157	.171
Switching Accuracy	.315	.054	-.107	-.027	.160	.150
Inhibition	-.237	-.044	.193	-.252	-.064	.048
Inhibition Switching	-.311	-.268	-.156	-.218	-.337	-.103
Tower Achievement Score	-.178	.248	.273	.175	.268	.048

Note. *p<0.05; **p<0.01

Driving and risk attitudes, and impulsivity. Table 7 displays the correlations for the young driver group and the adult driver group. As shown in the upper part of Table 7 regarding the young driver group, there were several statistically significant correlations between the risky driving measures (DV and DAQ) and the risk taking measures (AR and PRAI). The AR Total and both subscales had significant positive correlations with the DV and DAQ Total, and Speed and Drink subscales. DAQ Total and Drink subscale demonstrated significant negative correlations with PRAI Total and Health subscale. The DV was also

significant negatively correlated with PRAI Health but demonstrated a significant positive correlation with BIS.

For the adult driver group there were significant positive correlations between the AR Total and Psychological subscale and DV Total. Other significant positive correlations were between AR Psychological subscale and DAQ Total, Close Following, and Overtaking. PRAI Total and Health demonstrated a significant negative correlation with DAQ Total and Drink, while PRAI Health also demonstrated a significant negative correlation with DV Total.

The correlations in Table 7 suggest that for the young group, attitudes more agreeable to risk taking were highly associated with riskier driving attitudes, particularly speeding, drink driving and intentions of committing future driving violations. Furthermore, high impulsivity was strongly associated with a high intent of committing future driving violations, and a less risk averse attitude was strongly associated with a more agreeable attitude to drink driving. The adult group correlations in Table 7 indicate that there was a strong association between higher risk taking attitudes and riskier driving attitudes (particularly an inclination to commit future driving violations, close following, and overtaking).

Of note, the DV Total and DAQ Total for both groups had significant positive correlations with the AR Total and/or the AR Psychological subscale. The DAQ Total and DAQ Drink subscale for both groups also had significant negative correlations with PRAI Total and PRAI Health subscale. These similar group correlations suggest that for both young and adult drivers, riskier driving attitudes were strongly related with attitudes more agreeable to risk taking.

Table 7

Correlations between Driving Attitudes Questionnaires and Risk Attitudes Questionnaires for the Young and Adult Male Driver Groups

Young Driver Group	DV Total	DAQ Total	DAQ Speed	DAQ Drink	DAQ Close	DAQ Overtake
AR Total	.517**	.392**	.423**	.360*	-.020	.252
AR Physical	.431**	.331*	.333*	.281	.002	.245
AR Psychological	.465**	.354*	.394**	.345*	-.025	.193
BIS Total	.411*	.203	.313	.182	-.044	.066
PRAI Total	-.239	-.352*	-.270	-.337*	-.134	-.151
PRAI Sport	-.071	-.179	-.197	-.173	.006	-.093
PRAI Health	-.383*	-.461**	-.278	-.438**	-.271	-.176
Adult Driver Group	**DV Total**	**DAQ Total**	**DAQ Speed**	**DAQ Drink**	**DAQ Close**	**DAQ Overtake**
AR Total	.542**	.197	-.122	.188	.281	.205
AR Physical	.312	-.172	-.270	-.063	.066	-.212
AR Psychological	.542**	.421*	.034	.322	.356*	.463**
BIS Total	.246	.193	.071	-.075	.308	.306
PRAI Total	-.307	-.599**	-.302	-.377*	-.509**	-.531**
PRAI Sport	-.330	-.589**	-.398*	-.279	-.560**	-.498**
PRAI Health	-.219	-.475**	-.154	-.378*	-.354*	-.443*

Note. *p<0.05; **p<0.01

Risk attitudes, impulsivity, cognitive ability and executive function. Tables 8a (young driver group) and 8b (adult driver group) display the correlations between the attitudes to risk and impulsivity, and cognitive and executive function measures. Table 8a shows that there were several statistically significant correlations between the measures. AR (Total and subscales) had significant positive correlations with Performance IQ, Block Design, Matrix Reasoning, and

both Letter and Category Fluency. PRAI (Total and subscales) had significant negative correlations with Performance IQ and Matrix Reasoning, while PRAI Sport subscale had a significant positive correlation with Inhibition. These correlations suggest that for the young drivers, attitudes more agreeable to risk taking were linked to better or increased general cognitive ability (particularly Performance IQ) and better cognitive fluency. However, better inhibition was associated with a more risk averse or safer attitude.

Table 8a

Young Driver Group Correlations between Risk Attitudes & Impulsivity Questionnaires and Cognitive Ability & Executive Function Measures

	AR Total	AR Physical	AR Psychological	BIS Total	PRAI Total	PRAI Sport	PRAI Health
VIQ	-.024	-.053	-.014	.093	-.061	-.143	.064
PIQ	.522**	.381*	.490**	.167	-.389*	-.336*	-.328*
FSIQ	.282	.194	.260	.142	-.239	-.267	-.125
Vocabulary	-.158	-.110	-.208	-.077	-.045	-.164	.122
Block Design	.407*	.312	.371*	.199	-.261	-.168	-.292
Similarities	.119	.004	.198	.259	-.085	-.147	.022
Matrix	.506**	.364*	.478**	.074	-.437**	-.416**	-.319*
Cancellation Times	-.264	-.221	-.182	.211	.074	.029	.107
Trails Times	-.162	-.137	-.118	.229	-.128	-.104	-.116
Digits Total	.241	.301	.082	-.162	-.171	-.270	.012
Letter Fluency	.470**	.335*	.462**	.086	-.015	-.016	-.009
Category Fluency	.383*	.333*	.377*	.127	.282	.296	.171
Switching	.062	.020	.146	-.068	.068	.107	-.005
Switching Accuracy	.061	.079	.104	-.098	-.034	.025	-.097
Inhibition	-.075	-.091	-.054	.070	.282	.333*	.125
Inhibition Switching	.215	.156	.231	.287	-.072	.054	-.208
Tower Achievement Score	-.172	-.138	-.164	-.322	-.010	-.028	.016

Note. *p<0.05; **p<0.01

The adult group correlations displayed in Table 8b show that there were significant negative correlations between PRAI Health and Verbal IQ, Full Scale IQ, Vocabulary, Similarities, and Matrix Reasoning subtests. There was also a significant positive correlation between AR Physical and the Trails test (complex information processing). These correlations indicate that for the adult drivers,

there was a link between a less safe or less risk averse attitude (particularly regarding health) and increased or better general cognitive ability. Also, higher risk taking was associated with poor complex information processing (a higher Trails time means poorer complex information processing).

Table 8b

Adult Driver Group Correlations between Risk Attitudes and Impulsivity Questionnaires and Cognitive Ability & Executive Function Measures

	AR Total	AR Physical	AR Psychological	BIS Total	PRAI Total	PRAI Sport	PRAI Health
VIQ	.199	-.032	.312	-.096	-.238	.041	-.423*
PIQ	-.011	-.069	.038	-.004	-.109	.076	-.242
FSIQ	.153	-.076	.280	-.082	-.287	.018	-.485**
Vocabulary	.181	-.040	.293	-.021	-.239	.013	-.402*
Block Design	-.121	-.101	-.096	.103	.135	.234	.025
Similarities	.093	-.092	.206	-.106	-.274	.001	-.448*
Matrix	.030	-.108	.128	-.076	-.323	-.104	-.440*
Cancellation Times	-.351	-.174	-.370	-.038	.245	.289	.158
Trails Times	.142	.390*	-.101	-.048	.274	.098	.365
Digits Total	.041	-.295	.290	.240	-.220	-.130	-.250
Letter Fluency	.166	.139	.130	-.201	-.264	-.100	-.348
Category Fluency	-.012	.009	-.024	.069	-.233	-.172	-.236
Switching	.070	-.008	.107	.284	.009	.066	-.040
Switching Accuracy	.087	-.078	.186	.349	.011	.091	-.058
Inhibition	-.240	-.132	-.243	-.010	.068	.026	.090
Inhibition Switching	-.067	.013	-.106	.215	.175	.126	.181
Tower Achievement Score	-.142	-.130	-.102	.046	-.157	-.235	-.060

Note. *p<0.05; **p<0.01

Summary of findings. In general, the correlations for both young and adult drivers suggested that attitudes more agreeable to risk taking were strongly linked to riskier driving attitudes. Also, for the young drivers only, higher impulsivity was linked to higher intentions to commit future driving violations. Furthermore, the correlations for both groups generally indicated that better general cognitive

ability (particularly Performance IQ) and better executive functioning in particular areas (e.g., working memory, cognitive flexibility for young drivers; complex information processing for adult drivers) were associated with attitudes more agreeable to risking taking and risky driving. In contrast were correlations for the young drivers that showed poor fluency and switching were linked to a riskier driving attitude for close following, and that a safer attitude was linked to better inhibition. Also, for the adult drivers, poor complex information processing (Trails test) was linked to higher risk taking attitudes, which was in contrast with the link between better complex information processing and a more agreeable attitude to risky driving (drink driving).

Discussion

This study investigated the effect of age on male driver attitudes to driving and risk, impulsivity, cognitive ability and executive functions relative to safe driving. Overall, the group comparisons regarding attitudes and cognitive function showed several statistically significant differences between young and adult drivers. In terms of driving and risk attitudes, and impulsivity, the young drivers displayed attitudes much more approving of risk taking and risky driving, had significantly higher impulsivity, and were much more inclined to committing future driving violations. Regarding cognitive function, the adult drivers generally demonstrated higher cognitive ability and better executive functioning than the young drivers particularly in areas of sustained attention, fluency, and switching.

The correlations results revealed that for both driver groups, attitudes more agreeable to risk taking were shown to be strongly linked to riskier driving attitudes, while higher impulsivity was linked to greater intentions to commit future violations for young drivers specifically. Furthermore, for both groups, attitudes more agreeable to risk taking and risky driving were also generally shown to be linked to better cognitive ability and to better executive functioning in particular areas (i.e., working memory and cognitive flexibility for young drivers; complex information processing for adult drivers). However, there were some correlations that showed that a contrasting trend. That is, for young drivers poor fluency and switching were linked to a riskier driving attitude for close following, and a safer attitude was linked to better inhibition. For adult drivers, poor complex information processing was linked to higher risk taking attitudes. The following section discusses the results in more detail in relation to the three

main aims of this study and in relation to the wider research. Lastly, the limitations of this study and also implications for future research are discussed.

The driving history and the comparisons regarding driving and risk attitudes, and impulsivity revealed several differences between the young and adult drivers, some of which were statistically significant. The sample of young male drivers ages 16 to 18 was considered representative of many young New Zealand drivers at risk of being involved in a crash often involving death or serious injury. In relation to the overall driving history group comparisons, the adult drivers had held their restricted or full license on average considerably longer than the young drivers. For the reported 12 month period of driving, the adult drivers reported driving further on average per week than the young drivers, although the young drivers reported almost double the number of accidents and 'near misses'. Furthermore, in the same 12 month period, the young drivers also reported receiving more driving related convictions and warnings than the adult drivers.

These findings are consistent with New Zealand and international data and studies which show the disproportionate and higher crash rate for younger drivers (Begg & Langley 2001; Deery, 1999; Williamson, 2003; Ministry of Transport NZ, 2007). For instance, 8 of the 46 young male drivers (nearly 20%) reported having had at least one crash within a 12 month period in spite of the maximum period a driver's license had been held within that group was only 20 months.

Of particular interest were a small proportion of drivers (i.e., 3 young drivers and 2 adult drivers) that accounted for a large proportion of the reported accidents, near misses, and violations. However, further analysis of their individual results did not reveal any significant differences compared to the results of the other drivers in their groups to provide any explanation of the disproportionate reported incidences.

When comparing attitudes to driving, the young drivers were significantly more agreeable to risky driving behaviour and also more inclined to committing future driving violations related to speeding, close following, drink driving, or overtaking. The risk attitudes and impulsivity comparisons also revealed that the young drivers were less risk averse or more agreeable to risk taking and had significantly higher impulsivity than the adult drivers. More specifically the young drivers indicated they would engage in more risk taking activities than the adult drivers, regardless of the activity's nature or disapproval associated with it, and also because of certain desirable experiences (e.g. more fun) from the activity.

These differences between the age groups in terms of risky driving were similar to those reported by Begg and Langley (2001). Their longitudinal study had sought data from 936 young adults at age 21 years and at age 26 years using structured questionnaires to determine whether there was an age related change in the prevalence of a range of risky driving behaviours (e.g., driving after drinking, driving fast just for the thrill of it, taking deliberate risks for fun) and thrill seeking activities (e.g., sky diving, bungy jumping). Their results showed that among the males there was a highly significant change in the prevalence of most risky driving behaviours between ages 21 and 26 years and that by age 26, many of the males had "matured-out" of the risky driving behaviours. Although there are methodological and procedural differences between their study and the present study, the age related findings are similar in relation to the younger drivers displaying a higher level of risky driving propensity and also deliberately engaging in risky behaviour for fun.

The age differences in risk propensity found in the present study are also comparable to the findings of Hatfield and Fernandes (2009). Their study compared 277 younger (aged 16-25 years) and 110 older (aged over 35 years)

drivers in terms of risk propensity and related risk motivations to examine the association of these measures with risky driving. Hatfield and Fernandes found that compared to older drivers, younger drivers demonstrated lower risk aversion, higher propensity for accident, and stronger motives for risky driving. Furthermore, these variables were associated with risky driving, which was also associated with risk propensity, and risky behaviour in other domains (this will be commented on further in discussing the correlations results).

Regarding the higher impulsivity displayed by the young drivers, these findings are similar to Steinberg's recent study (2010) using the Barrett Impulsivity Scale (BIS) to explore age differences in impulsivity. From a sample of 935 individuals between the ages of 10 and 30, using multiple regression analyses, Steinberg found a linear effect of age on impulsivity, or in other words impulsivity declined with age. While there are differences between this current study and Steinberg's regarding participant age range and analysis of the data, the link of impulsivity and age are apparent in both cases. In terms of impulsivity and driving, impulsivity and other personality characteristics (such as extraversion, social deviance) have been indicated as specific contributing factors to unsafe driving particularly for male drivers (Beirness, 1993; Hansen, 1988; Owsley, McGwin & McNeal, 2003; William, Henderson, & Mills, 1974).

The higher level of risk propensity and impulsivity found with the young driver group concurs with the literature regarding adolescence being described as a period of heightened risk in general where risk taking is hardwired into the adolescent brain (Reyna & Farley 2006). This heightened risk propensity and impulsivity manifests in difficulties with controlling behaviours and emotions which leads to subsequent behaviours such as accidents, suicide, homicide, depression, alcohol and substance abuse, violence, risk taking, sensation seeking

and eating disorders (Dahl, 2004). As Reyna & Farley (2006) put it- compared to adults, children and adolescents have been found to be less able to delay gratification or inhibit their behaviour, plan for or anticipate the future, spontaneously bring consequences to mind, or learn from negative consequences. Reyna & Farley (2006) explain further that adolescents often do not view consequences as being as harmful as adults do, and often behave more impulsively (beyond individual differences that may linger into adulthood), reacting to immediate temptations without thinking and discounting future rewards more heavily than adults do.

It is important to note that the overall internal reliability for the DAQ for this study's sample was somewhat low. Hence, while the young drivers demonstrated higher risky driving attitudes, data from this questionnaire should be interpreted with some caution. However, in terms of the overall impact of age on risk taking, risky driving, and impulsivity, the results suggest that impulsivity decreased with age as indicated by the significantly lower impulsivity displayed by the adult drivers compared to the young drivers. Furthermore, attitudes more agreeable to risk taking and risky driving also reduced with age, as seen in the more risk averse/safety conscious attitudes of the adult group.

For cognitive ability and executive function, there were some statistically significant differences between the young and adult drivers. In terms of cognitive ability, the adult drivers demonstrated significantly better performance IQ ability than the young group. For specific executive functions, the adult drivers had significantly better sustained attention, fluency and switching ability. The adult drivers also demonstrated slightly better complex information processing (Trails test), working memory (Digits forward and backward), cognitive flexibility (inhibition/switching) and forward planning and problem solving (Tower Test)

ability compared to the young group. In terms of the differences shown between the young and adult drivers in this present study regarding cognitive function suggested to be important for safe driving, some similarities may be seen in studies of drivers with frontal lobe deficits.

For example, Rizzo, McGehee, Dawson & Anderson (2001) compared older drivers in terms of driving safety using Block Design and Trails among other tests. They found that the impaired older drivers had poorer visuo-motor abilities and executive functions compared to the drivers without deficits. Similarly, a study by Lundqvist (2001) found that drivers with brain injury displayed poorer working memory, reduced information processing speed, and poorer divided and focused attention, which were important to safe driving. Also, Donnelly et al. (1992) found differences in cognitive function amongst 21 healthy and 12 cognitively impaired middle-aged and elderly participants in terms of their performance on tests of mental status, neuro-psychological performance, driving knowledge, vision, and complex reaction time. Stroop (Colour/Word Interference test) scores of impaired participants were found to be significantly lower than those of the control group (Donnelly et al., 1992).

While there are limitations in the studies with older adult samples, as well as apparent design and sample differences, they at least provide some useful evidence regarding the link between executive functions and driver performance. They also provide useful group comparisons that offer some insight into the differences that would be expected between underdeveloped or damaged executive function and fully developed, unimpaired executive function.

In terms of the correlations carried out for the measures of attitudes, impulsivity and cognitive function, the intention was to obtain further insight into how each of these domains related to each other. Overall the findings indicate that

there was a strong link between higher risk propensity and riskier driving attitudes, which were both strongly associated with higher cognitive ability especially for the young group. Furthermore, for the young drivers specifically, higher impulsivity and higher risk taking attitudes were strongly linked with higher intentions to commit future driving violations.

The link between risk propensity and risky driving is abundantly apparent in the literature, particularly regarding young drivers. In other words, young driver risk propensity manifests in several ways, including risky driving behaviours such as speeding, following too closely, and rapid lane changes, which significantly correlate with a greater risk for crashes (Elander, West, & French, 1993; Preusser, Ferguson, & Williams, 1998).

The findings in the present study of the link between risk propensity and risky driving and also between risk aversion and risky driving are comparable to the findings by Hatfield & Fernandes (2009). They found several risk taking variables (e.g. lower risk aversion, risk-related motives for risky driving, excitement, sensation-seeking, underestimation of risk, irrelevance of risk) to be associated with risky driving. Hatfield & Fernandes concluded that risky driving was associated with risk propensity and also risky behaviour in other domains, which has been referred to as clustering or co-occurrence of risky behaviour (Vernick, Li, Ogaitis, et al., 1999). The link between risk taking and risky driving is also similar to the findings by Clarke, Ward & Truman (2005) who investigated motivational factors underlying driving behavior of UK young drivers aged 17 to 25 years. They found that young driver accidents were more frequently the result of ‘risk taking’ factors as opposed to ‘skill deficit’ factors (Clarke, Ward & Truman 2005).

Regarding impulsivity and its link to committing future driving violations, somewhat similar findings are shown in studies where impulsivity and other personality characteristics (such as extraversion, social deviance) have also been indicated as contributing factors to unsafe driving particularly for males (Beirness, 1993; Hansen, 1988; William, Henderson, & Mills, 1974). For instance, Owsley, McGwin & McNeal (2003) explored three personality dimensions (impulsiveness, venturesomeness, and empathy) in relation to driving amongst 305 older drivers (ages 57–87 years old). Their results showed that subjects who reported driving errors and driving violations were more likely to have high impulsivity scores. Also, Dahlen, Martin, Ragan, and Kuhlman (2005) investigated the correlation between driving anger, sensation seeking, impulsiveness, and boredom proneness with aggressive and risky driving in a survey of university students. They found modest contributions from impulsiveness towards aggressive and risky driving.

The link between cognitive ability (intelligence) and risky driving as shown in the findings of this study are not directly addressed in any of the literature reviewed. However, some of the previous studies referred to show links between education and intelligence relative to crash involvement. For instance, Murray (1998) found that male drivers with high involvement in accidents tended to have lower school grades than the average for males in the population. Vaez and Laflamme (2005) found that among all drivers less than 30 years of age who were involved in crashes, the odds of severe injury were higher for the youngest drivers, for drivers who were impaired by alcohol, and for drivers with less education. Similarly, Sanchez Martin & Estevez (2005) found that young drivers with lower practical intelligence and less education were also involved in more accidents.

The present study's correlations appeared to be in contrast with the findings of the studies mentioned regarding the link between cognitive ability and driving. Unlike the findings of the mentioned studies, the present study's correlations indicated that higher (not lower) cognitive ability/intelligence was linked to riskier driving attitudes. Considering that the mentioned studies looked at the link between intelligence or education and crash involvement, it is difficult to make direct and meaningful comparisons between the present study's findings (in terms of correlations) and the aforementioned findings. A more meaningful comparison may have been achieved if the present study had carried out correlations between self reported accident involvement and cognitive ability. However, there were very few participants with self reported accidents to obtain statistically meaningful results. Furthermore, unlike the studies mentioned which linked lower than average grades or intelligence to higher crash involvement, all the participants in this study scored within or above the average range in terms of IQ or cognitive ability

Of interest, and in contrast to the cognitive ability correlations, were the correlations that associated poor executive functions with higher risk taking or riskier driving attitudes. For instance, correlations for the young drivers linked poor fluency and switching to a riskier driving attitude for close following, and also linked a safer attitude to better inhibition. Also, for the adult drivers, poor complex information processing was linked to higher risk taking attitudes. These findings are somewhat in line with findings associating poor executive function with poor driving performance. An example is the study by Galski et al. (1993) which found a link between poor executive function to poor performance in an on-road evaluation.

Clearly more research is still required to provide more certainty regarding the link between intelligence and risky driving attitudes and also between executive function and driving attitudes. In saying this, the present study's findings in terms of some of the correlations associating poor executive function with higher risk taking or riskier driving have at least provided some useful areas of focus which can be explored further in future research.

Collectively the group comparisons revealed apparent age differences regarding, cognitive ability and function, risk propensity related to risk taking and risky driving, and impulsivity. In other words, age appeared to have an effect on these domains. Furthermore, the correlations revealed a strong link between high risk taking attitudes and riskier driving attitudes. These findings generally concur with the literature, and also all relate to factors which contribute to the higher crash risk of young drivers, and which are implicated as essential to safe driving. Given the interrelationships shown between these different domains and their apparent impact on safe driving, it is essential that approaches to address the 'young driver problem' are multifaceted, multileveled, and engage the target population in the development and implementation of targeted strategies (Juarez, 2006; Williams, 2006).

In other words, relying on only a single method or one dimensional approach such as road safety media campaigns are not likely to be sufficient to address the several factors related to the 'young driver problem. For example, it is important to focus early on driving and hazard detection skills in young people to ensure these skills become automated. However, this approach alone may be ineffective in addressing factors such as high risk propensity, and impulsivity associated with adolescence.

Graduated driver licensing systems (GDLS) such the current system in New Zealand since 1987, have been shown to be effective in addressing risk factors associated with young drivers. In the United States graduating licensing has reduced crashes generally by 20-30% (Williams, 2006), and in New Zealand it has resulted in a substantial reduction in car crash injuries for the 15-19 year old age group (Langley et al., 1996). Graduated licensing accomplishes this by serving a dual purpose in addressing risk factors related to inexperience and age. It does so by delaying initial licensure and by controlling exposure to driving situations (e.g., night driving, driving with other young passengers) where risk can be exacerbated by the immaturity factor (Williams, 2006). However, low compliance with the restrictions of the GDLS is an ongoing concern. Also, with the continued high crash rates for younger drivers particularly between ages16-18 years there are questions as to whether the initial licensing age should also be lifted to a later age, to further control for the impact of age.

An effective strategy is likely to be a comprehensive and well coordinated community based program, with strong graduated licensing laws as a foundation (Juarez, 2006). It would also require the integration of modern education and training techniques both on and off road (e.g., simulated driving conditions/road commentary), multileveled, well publicised enforcement and prevention strategies, with involvement and input of the target group, their parents and police (Juarez, 2006; Williams, 2006).

There are some key limitations in this study which provide useful ideas for future study in the area of young drivers and risk propensity. A common issue in young driver research which may also exist in this study is the confounding influence of experience over age in terms of determining the extent to which either of the variables or a combination of the two has influenced results. The

confounding influence of driver experience over age in this study also applies to the adult group although it is difficult to recruit a novice older driver group. In terms of future research comparing young and older drivers, and considering the difficulty of recruiting novice older drivers, an approach that may at least partially mitigate this confounding issue would be to recruit only young drivers with a minimum of at least 2 years driving experience. However, in terms of relative impact, the literature shows that age compared to experience has the greatest effect on driving, even after experience is accounted for (Mayhew et al., 2003).

Another limitation is likely related to the relatively small sample size (young n= 45; adult n= 32) and the imbalance of participant numbers in each group which may have contributed to insufficient statistical power to reveal further significant statistical effects than what were shown (i.e., a Type 2 error). Whilst having a larger sample size may have assisted with the statistical power of the results, the time constraints of this study and the challenges of recruiting adult males in particular were factors limiting the sample size.

Many of the participants both in the young and adult group were 'self-selecting' in responding to the ads which has influenced to a certain extent, the demographic characteristics of the participants. This is particularly the case for the adult sample, who were mainly married or in a steady relationship, and many of whom had tertiary level qualifications and all of whom were in full-time employment. This may have affected the results particularly regarding general ability and executive function, if no one in the young sample were in school. However, this was not the case.

It is important to note that the measures used in this study are themselves only indices which are thought to be useful in measuring attitudes and function that are important in actual driving. However, they do not measure these functions in the

context of either simulated or actual driving. In terms of future research, the use of simulated driving tests relative to testing executive function important to driving (e.g., video based traffic simulation for the hazard perception) would be beneficial in providing further data to compare differences between the groups, particularly about actual impact of function on driving. It would also provide data around how individuals actually respond in real life settings, which would help determine whether their self-reported behaviour is congruent with their actions.

Carrying out correlations using the driving history statistics of reported accident involvement in relation to cognitive ability and function and risk propensity would have also been useful in providing a clearer picture as to their associations with each other. While it was not considered in this study because of an insufficient number of participants involved in accidents to obtain statistically meaningful results, it would be useful to consider where there are a sufficient number of participants reporting accident involvement.

In the context of this study, age has been shown to be a factor affecting risk propensity, impulsivity, cognitive ability and executive function of male drivers. In the wider context of driving, these are considered to be important factors contributing to the high crash rate of young people and therefore warrant a comprehensive strategy to address them. A strategy considered to be effective is one that would incorporate a holistic approach to train young drivers in executive functions important for driving, and also address the issues of risk propensity, impulsivity and the influence of peers on driving. It would also ensure that young drivers are actively involved in its development and implementation along with their families and wider community. Further research is needed to provide more robust data that will help to better understand the ‘young driver problem’, to

refine current strategies and identify other ways to further reduce their crash involvement.

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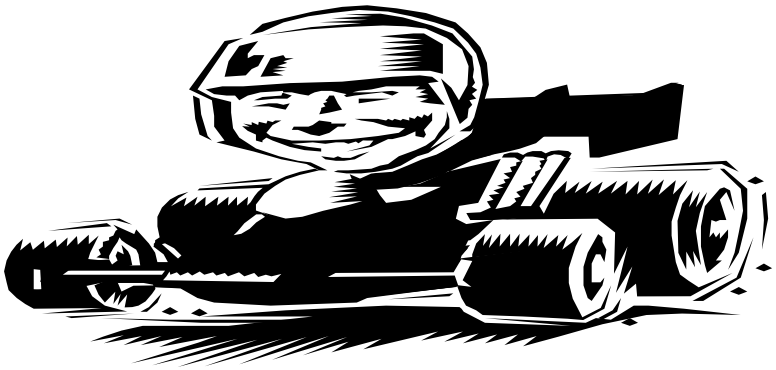
Appendix A

Advertisement

Thinking and driving: A study assessing male driving behaviour



What is this study about?

- The study looks at how different men plan, assess risk and make decisions and how this effects our driving.
- We will be using an online survey and carrying out someone to one tasks
- Your participation is voluntary (your choice)
- The study is being conducted by Dr. Robert Isler, Dr. Nicola Starkey, Dr. Andrea Hodgetts and James Moleni in the Department of Psychology, University of Waikato.

Am I eligible to take part?

- You have a valid full or restricted car driver licence for more than six months
- Are male, aged between 16-17, 20-21, 25 years and over
- Can speak and read NCEA Level 1 English

What am I being asked to do?

- To fill out a survey, which will take around 30-45 minutes
- To complete a series of one to one tasks, which will take 60-75 minutes
- **To cover your expenses we will give you a $20 MTA voucher or you can claim 2% course credit**

Who can I speak with about my participation in this project?

- Call Nicola Starkey on 856 2889 extension 6472, or email drivingproject@waikato.ac.nz.

Appendix B

Information Sheet

Thinking and driving: A study assessing male driving behaviour

Information Sheet

What is this study about?

You are invited to participate in a research project investigating how different men plan, assess risk and make decisions and how this effects our driving.
Your participation is voluntary (your choice). The main aim of this study is to assess drivers, their background, driving behaviours, and decision making skills. We will be using two research methods; a survey and one to one tasks.

This study is being conducted by Dr. Robert Isler, Dr. Nicola Starkey, Dr. Margaret Drew, Dr Andrea Hodgetts and James Moleni from the Department of Psychology at Waikato University.

Am I eligible to take part?

You are eligible to take part in this study if you have a valid full or restricted car driver licence for more than six months; male, aged between 16 to 17, 20 to 21, or over 25; can speak and read NCEA Level 1 English.

What am I being asked to do?

This study is in two parts. **Firstly**, if you agree to take part, you will be asked to fill out an anonymous survey. This survey contains questions about you, your background, your driving experiences, and how risky you rate various types of recreational activities. This will take around 30 - 45 minutes to complete.
Secondly, you will be asked to complete a series of one to one tasks which assess your mood, concentration and attention and how you make decisions. These tasks will take 60 minutes to complete. Please collect the survey from the psychology office and then contact James (email drivingproject@waikato.ac.nz) to arrange a time to complete the one to one tasks.
There are no right or wrong answers to the survey questions or the one to one tasks. Refreshments will be provided and in total your participation will involve no more than two hours. To cover your expenses relating to your involvement in this

project we will give you a $20 MTA voucher or you will receive 2% course credit. In addition, you may be placed in a draw to win a $50 MTA voucher.

What will happen to my information?

Be assured that no one will be able to identify you. All returned surveys and the paper-based one to one tasks are to be stored in a locked cabinet, in the Department of Psychology at Waikato University. The research team will conduct the analysis of the data. At the end of the study the paper-based forms will be destroyed. We will send an electronic summary of our findings to the participants who have indicated they would like to receive this information.

What can I expect from the researchers?

If you decide to participate in this project, the researchers will respect your right to:

- ask any questions of the researchers about the study at any time during participation;
- decline to answer any particular question and tasks in the on-line survey or in the one to one tasks;
- withdraw from the study;
- provide information on the understanding that it is completely confidential to the researchers. All surveys are identified by a code number, and are only seen by the researchers. It will not be possible to identify you in any articles produced from the study;
- be given an electronic summary of the findings

Who can I speak with about my participation in this project?

If you have any further questions or concerns, please contact Nicola Starkey on 07 8562889 ext 6472 or email at drivingproject@waikato.ac.nz. If you have any concerns about this project, you may contact the convenor of the Research and Ethics Committee (Linda Nikora; 07 8562889 ext 8200. email l.nikora@waikato.ac.nz)

Appendix C

Consent form

University of Waikato
Psychology Department

CONSENT FORM

PARTICIPANT'S COPY

Research Project:

Name of Researcher:

Name of Supervisor (if applicable):

I have received an information sheet about this research project or the researcher has explained the study to me. I have had the chance to ask any questions and discuss my participation with other people. Any questions have been answered to my satisfaction.

I agree to participate in this research project and I understand that I may withdraw at any time. If I have any concerns about this project, I may contact the convenor of the Research and Ethics Committee (Dr Robert Isler, phone: 838 4466 ext. 8401, e-mail r.isler@waikato.ac.nz)

Participant's
Name:_____Signature:_____Date:_____

Appendix D

Survey Cover Sheet

Thinking and driving: A study assessing male driving behaviour

Survey Cover Sheet

Please follow these steps in completing this survey:

1. Remember to write the ID number that is given to you in the tear-off section at the bottom of this page and in the top right hand corner of the first page of the Demographics section where it says 'Number'

2. Once you have completed all 14 pages, please double check each page to make sure you haven't left any information out.

3. Tear off your ID number at the bottom of this page and hold onto it to present the ID number to James Moleni when you see him at the assessment time you have scheduled with him.

4. Drop off your completed survey at the Psychology Office reception (Level 2, K block).

5. If you haven't already booked a time for the **second part** of the study, be sure to do so with James Moleni either by email at drivingproject@waikato.ac.nz or by texting 021 182 4867 or ???

If you have any further questions or concerns, please contact Nicola Starkey on 07 8562889 ext 6472 or email at drivingproject@waikato.ac.nz. If you have any concerns about this project, you may contact the convenor of the Research and Ethics Committee (Linda Nikora; 07 8562889 ext 8200. email l.nikora@waikato.ac.nz)

Cut/Tear Off here _ _ _ _ ___ _ _ _ _ _ _ _ _ _ _ _ _ _ ___ ___ _ _ _ _ _ _ _ _ _ _ _ _

My ID number for this Driving Project is:_____

Appendix E

Demographics Questionnaire

Driving Project

Instructions
Please provide the following information by typing your response in the appropriate boxes

1. What is your date of birth?

☐ ☐ ☐
Day Month Year

2. Please indicate which best describes your ethnic background:

☐ New Zealand European
☐ New Zealand Māori
☐ Asian
☐ Pacific Islander
☐ None of the above, please specify_____

3. Are you currently

☐ single
☐ in a relationship
☐ married / civil union
☐ divorced
☐ widowed

4. What type of drivers licence do you hold?

☐ restricted for car
☐ full for car

5. What date did you obtain your restricted / full **car** driving licence?

☐ ☐
Month Year

6. How many kilometers do you drive in a usual week?
☐ km

Instructions
Almost every driver becomes involved in an adverse traffic event (accident or near-miss) of some sort during their driving years. We would like to know how often people experience such events. Please tell us how many ACCIDENTS or NEAR MISSES that you have been involved in during **the last twelve months.**

7. In the last twelve months, how many accidents have you been involved in?
An *accident* is any collision that occurred *on the public roads* (but not private property), while you were the driver of the vehicle and irrespective of who was at fault.

☐ accidents

8. In the last twelve months, how many near misses have you experienced?
A *near miss* is when you narrowly avoided being in an accident on public roads, while you were the driver of the vehicle and irrespective of who was at fault.

☐ near misses

Instructions
Nearly all drivers commit traffic offences and we would like to estimate how often these happen. Please let us know whether you have committed any traffic offences **in the last twelve months.** For each of the offences below indicate approximately **how many times** these happened. **Please write the number of times in the space provided.**
A conviction is when your offence has legal consequences resulting in a fine and / or demerit points.
A warning is when you are stopped by the police regarding your driving but no further action is taken.

Offence type	**Convictions**	**Warnings**
Speeding		
Racing		
Reckless driving		
Drinking or drug related e.g. driving under the influence		
Dangerous overtaking e.g. overtaking with limited visibility		
Following too close		
Roundabout offences e.g. using the wrong lane, inappropriate signals		
Failing to obey road signs (e.g. a stop sign)		
Traffic signal offence e.g. running a red light		
Parking offence e.g. parking in disabled parking, on		

footpath		
Failing to stop e.g. for police, after an accident		
Vehicle defects e.g. broken headlamp, noisy vehicle		
Uncertified vehicle modification e.g. lowered suspension		
Seatbelt offence		
Taking a vehicle without consent		
Driver Licence offense e.g. driving whilst disqualified, outside of license restrictions		
Driving without a warrant of fitness		
Driving without registration		

Other, please provide a detailed list

Appendix F

Driving Violations Questionnaire

Driving Project: DV **Number _____**

Instructions
Every driver makes occasional mistakes. Even the best drivers make errors or bend the rules sometimes. For each of the statements below indicate how likely you are to engage in this type of behaviour **in the future**. If you would never engage in that behaviour **circle 0**, if you think you will carry out the behaviour very frequently or most of the times that you drive **circle 4**. Use the remaining numbers to indicate the varying likelihood of your carrying out that behaviour.

In the future, how often would you expect to do each of the following?

Hardly ever 0%	**Close to 25% of the time**	**Close to 50% of the time**	**Close to 75% of the time**	**Nearly 100% of the time**
0	**1**	**2**	**3**	**4**

1.	Drive especially close to the car in front as a signal to its driver to go faster to get out of the way	0	1	2	3	4
2.	Become impatient with a slow driver in the outer lane and overtake on the inside	0	1	2	3	4
3.	Cross a junction knowing that the traffic lights have already turned against you	0	1	2	3	4
4.	Angered by another driver's behaviour, you give chase with the intention of giving him/her a piece of your mind	0	1	2	3	4
5.	Disregard the speed limits late at night or very early in the morning	0	1	2	3	4
6.	Drive even though you realize you may be over the legal blood-alcohol limit	0	1	2	3	4
7.	Have an aversion to a particular class of road user, and indicate your hostility by whatever means you can	0	1	2	3	4
8.	Get involved in unofficial 'races' with other drivers	0	1	2	3	4
9.	Exceed the 100 km/h speed limit on the open road	0	1	2	3	4
10.	Drive fast	0	1	2	3	4
11.	Exceed the 50 km/h speed limit in built-up areas	0	1	2	3	4

Appendix G

Driver Attitude Questionnaire

Driving Project :DAQ a **Number**

Instructions
To what extent do you agree or disagree with each of the following statements? Please read each statement carefully, and then **circle** the number that corresponds to your reply.

Strongly disagree	**Disagree**	**Neither agree or disagree**	**Agree**	**Strongly agree**
1	**2**	**3**	**4**	**5**

1.	Some people can drive perfectly safely after drinking three or four pints of beer	1	2	3	4	5
2.	People stopped by the police for close following are unlucky because lots of people do it	1	2	3	4	5
3.	I would welcome further use of double yellow lines to let me know when it is unsafe to overtake	1	2	3	4	5
4.	Speed limits are often set too low, with the result that many drivers ignore them	1	2	3	4	5
5.	I think the police should start breathalysing a lot more drivers around pub closing times	1	2	3	4	5
6.	It is quite acceptable to take a slight risk when overtaking	1	2	3	4	5
7.	Close following isn't really a serious problem at the moment	1	2	3	4	5
8.	I know exactly how fast I can drive and still drive safely	1	2	3	4	5
9.	Some drivers can be perfectly safe overtaking in situations which would be risky for others	1	2	3	4	5
10	Even one drink makes you drive less safely	1	2	3	4	5
11	I would favour stricter enforcement of the speed limit on 50 km per hour roads	1	2	3	4	5
12	Some people can drive perfectly safely even when they only leave a small gap behind the vehicle in front	1	2	3	4	5
13	The aim of the police should be to stop as many people as possible overtaking in risky circumstances	1	2	3	4	5
14	Even driving slightly faster than the speed limit makes you less safe as a driver	1	2	3	4	5
15	It's hard to have a good time if everyone else is drinking but you have to limit yourself because you're driving	1	2	3	4	5
16	I would be happier if close following regulations were more strictly applied	1	2	3	4	5
17	Stricter enforcement of speed limits on 50kmph roads would be effective in reducing the occurrence of road	1	2	3	4	5

	accidents					
18	Even driving slightly too close to the car in front makes you less safe as a driver	1	2	3	4	5
19	I think it is O.K. to overtake in risky circumstances as long as you drive within your own capabilities	1	2	3	4	5
20.	The law should be changed so that drivers aren't allowed to drink any alcohol	1	2	3	4	5

Appendix H

Physical Risk Assessment Inventory

Driving Project: PRAI **Number _____**

Instructions
Circle the appropriate number for each of the following activities to indicate their level of physical risk to **an average person**. In each case **click** any number from **0** (**No Physical Risk**) to **6** (**Extreme Physical Risk**).

No Physical Risk **Moderate Physical Risk** **Extreme Physical Risk**

0 1 2 3 4 5 6

1	Mountain climbing	0	1	2	3	4	5	6
2	Smoking marijuana	0	1	2	3	4	5	6
3	Water skiing	0	1	2	3	4	5	6
4	Eating fatty foods	0	1	2	3	4	5	6
5	Parachute jumping	0	1	2	3	4	5	6
6	Skiing fast down a mountain	0	1	2	3	4	5	6
7	Being sexually promiscuous	0	1	2	3	4	5	6
8	Scuba diving	0	1	2	3	4	5	6
9	Driving recklessly	0	1	2	3	4	5	6
10	Heavy drinking	0	1	2	3	4	5	6
11	Rock climbing	0	1	2	3	4	5	6
12	Hang gliding	0	1	2	3	4	5	6
13	Using hallucinogenic drugs	0	1	2	3	4	5	6
14	White water kayaking	0	1	2	3	4	5	6
15	Using illegal stimulants	0	1	2	3	4	5	6
16	Smoking cigarettes	0	1	2	3	4	5	6
17	Mountain biking	0	1	2	3	4	5	6
18	Having unprotected sex	0	1	2	3	4	5	6
19	Piloting a small plane	0	1	2	3	4	5	6

20	Using cocaine	0	1	2	3	4	5	6
21	Surfing	0	1	2	3	4	5	6
22	Not exercising regularly	0	1	2	3	4	5	6
23	Driving after drinking alcohol	0	1	2	3	4	5	6
24	Horse riding	0	1	2	3	4	5	6
25	Ocean sailing	0	1	2	3	4	5	6
26	Using heroin	0	1	2	3	4	5	6
27	Diving off a high board	0	1	2	3	4	5	6

Appendix I

Attitudes toward Risk Questionnaire

Driving Project: AR **Number** _____

Instructions
Indicate using a 5 point scale the degree to which each of the following statements describes you.

Circle 1 to indicate it does not describe you at all (**not like me**) and **circle 5** if the description is a very good description of you (**like me**). Use remaining numbers to indicate the varying degrees that the statement is like you or not like you.

Please read each statement carefully and then circle the number that corresponds to your reply.

Not Like Me **Like Me**

1 **2** **3** **4** **5**

1	I like the feeling that comes with taking physical risks	1	2	3	4	5
2	While I don't deliberately seek out situations or activities that society disapproves of, I find that I often end up doing things that society disapproves of.	1	2	3	4	5
3	I often do things that I know my parents would disapprove of	1	2	3	4	5
4	I consider myself a risk-taker	1	2	3	4	5
5	Being afraid of doing something new often makes it more fun in the end	1	2	3	4	5
6	The greater the risk the more fun the activity	1	2	3	4	5
7	I like to do things that almost paralyse me with fear	1	2	3	4	5
8	I do not let the fact that something is considered immoral stop me from doing it	1	2	3	4	5
9	I often think about doing things that I know my friends would disapprove of	1	2	3	4	5
10	I often think about doing things that are illegal	1	2	3	4	5

Appendix J

Barratt Impulsivity Scale

Driving Project: BIS **Number** _____

Instructions
We all act and think differently in day to day situations. Please read each statement and circle the answer that best describes the way you act and think. Do not spend too much time on any one statement. **Answer quickly and honestly.**

Rarely/Never **Occasionally** **Often** **Almost always/always**

1 **2** **3** **4**

1.	I plan tasks carefully	1	2	3	4
2.	I do things without thinking	1	2	3	4
3.	I am happy-go-lucky	1	2	3	4
4	My thoughts race	1	2	3	4
5	I plan trips well ahead of time	1	2	3	4
6	I am self-controlled	1	2	3	4
7.	I concentrate easily	1	2	3	4
8.	I save regularly	1	2	3	4
9.	I find it hard to sit still for long periods of time	1	2	3	4
10.	I am a careful thinker	1	2	3	4
11.	I say things without thinking	1	2	3	4
12.	I like to think about complex problems	1	2	3	4
13.	I change jobs	1	2	3	4
14.	I act on impulse	1	2	3	4
15.	I get easily bored when solving though problems	1	2	3	4
16.	I have regular medical/dental check ups	1	2	3	4
17.	I act on the spur of the moment	1	2	3	4
18.	I am a steady thinker	1	2	3	4
19.	I buy things on impulse	1	2	3	4
20	I finish what I start	1	2	3	4
21.	I walk and move fast	1	2	3	4
22.	I solve problems by trial and error	1	2	3	4
23.	I spend or charge more than I earn	1	2	3	4
24.	I talk fast	1	2	3	4
25.	I have outside thoughts when thinking	1	2	3	4
26.	I am more interested in the present than the future	1	2	3	4
27.	I am restless in class/groups	1	2	3	4
28.	I plan for the future	1	2	3	4

Appendix K

Participant Instructions

Welcome participant.
Information as to where the toilets are

Instruction:
I'll be asking you to do a number of things today like defining words and solving different kinds of problems and I will be asking how you've been feeling during the past two weeks. Remember most people can't complete or finish all the tasks, but please give your best effort on all the items.

Do you have any questions about what we are going to do today?

CANCELLATION TEST

Match with Master Sheet : Information
Name:
ID Number:
Age:
Year at school:

Say:
"Do you see these letters? Whenever you see a C and an E, I want you to put a line through it. Try and do this as fast as you can. Any questions? Begin."

Time: Start timing as the subject is told to begin. At 1 minute make a mark . Note total time taken. Whenever it is necessary, the instructions are repeated. The examiner will not start testing until s/he is convinced that the participant understands the instruction correctly.

TRAILS TEST

Place the Part B test sheet sample side up, flat on the table directly in front of the participant.
Give the participant a pencil

Say:

On this page (point) are some numbers and letters. Begin at number 1 (point) and draw a line from 1 to A (point), A to 2 (point to 2), 2 to B (point to B), B to 3 (point to 3), 3 to C (point to C) and so on, in order, until you reach the end (point to the circle marked end). Remember, first you have a number (point to 1) and then a letter (point to A) then a number (point to 2), then a letter (point to B) and so on. Draw the lines as fast as you can.... Ready, Begin.

Correct: Say Good. Let's try the next one. Proceed immediately to Part B.

Time: start timing as the subject is told to begin.

Incorrect:

Point out the mistake to the participant. For example:

1. You started with the wrong circle. This is where you start (point to number 1)
2. You skipped a circle (point to the circle omitted). You should go from 1 (point to 1) to A (point), A to 2 (point to 2), 2 to B (point to B), B to 3 (point to 3) and so on until you reach the circle marked end.

Then Say:

Now try it, remember, you begin at number 1 (point to 1) and draw a line from 1 to A, A to 2, 2 to B, B to 3, and so on until you reach the circle marked end. Ready- Begin.

Correct: Go to Part B

Incorrect: Repeat the procedure until he succeeds, or it becomes evident that he cannot do the task.

DIGIT SPAN

General Directions:

The 2 parts of the Digit Span- digits forward and digits backward- are administered separately. **Administer digits backward even if the examinee obtains a score of 0 on digits forward.**

Administer both trials of each item even if the examinee passes trial 1.

Read the digits at the rate of one per second, dropping your voice inflection slightly on the last digit in the sequence. Pause to allow the examinee to respond.

<u>Digits Forward</u>: Start: Trial 1 of item 1.

Discontinue: After a score of 0 on both trials of any time

Say:

I am going to say some numbers. Listen carefully, and when I through, I want you to say them right after me. Just say what I say.

<u>Digits Backward</u>: Start: Trial 1 of item 1.

Discontinue: after a score of 0 on both trials of any time.

Say:

Now I am going to say some more numbers. But this time when I stop, I want you to say them backward. For example, if I say 7-1-9, what would you say?

Correct: (9-1-7): That's right (proceed to Trial 1)

Incorrect: say- No you would say 9-1-7. I said 7-1-9, so say it backward, you would say 9-1-7. Now try these numbers. Remember you are to say them backward: 3-4-8.

Do not provide any assistance on this example or any of the items. Whether or not the examinee responds correctly, proceed to Trial 1 of item 1.

Beck Anxiety Inventory

Say:

Below is a list of common symptoms of anxiety. Please carefully read each item in the list. Indicate how much you have been bothered by each symptom during the past week, including today, by placing an X in the corresponding space in the column next to each symptom.

Columns:

- Not at all
- Mildly- It did not bother me much
- Moderately- It was very unpleasant but I could stand it
- Severely- I could barely stand it

Total Scores:

- Moderate 16 to 25 or Severe 26 to 63.

Beck Depression Inventory

Say:

This questionnaire consists of 21 groups of statements. Please read each group of statements carefully, and then pick out the one statement in each group that best describes the way you have been feeling during the past 2 weeks including today. Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than 1 statement for any group, including item 16 (changes in sleeping pattern) or item 18 (changes in appetite).

Check items: 2 & 9, if higher than 3- inquire

Total Scores:

- Moderate 20 to 28
- Severe 29 to 63
- Below 4 could be faking good and lower than normal scores.

Services: The Psychology Centre, 2 Von tempsky St Hamilton: 07 834 1520.